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NOTICE.

Owing to impracticability of sending out more than a very limited number of, if any, advance copies of the articles, in the various numbers, and thereby reaching all the members, such appropriate discussions as may be contributed by members after the issue of a number will be printed in the succeeding number. In the case of certain leading articles a limited number of advance copies will be sent out in addition, as may be requested by authors, as hitherto.

J. H. GLENNON,
Secretary and Treasurer.

NOTICE.

Through an error made by the printer after the final reading of the proof, the words "Honorably Mentioned" were omitted from the heading of the essay on the Battle of the Yalu in No. 75.

The chart referred to, in this essay, as published by the Intelligence Office (pp. 480 and 510 of No. 75), is not from that Office, being in fact H. O. chart 1443.

J. H. GLENNON,
Secretary and Treasurer.

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AS TO NAVY-YARDS AND THEIR DEFENSE.*

BY REAR-ADMIRAL S. B. LUCE, U. S. Navy, President of the U. S. Naval Institute.

On the formation of the government under the constitution of 1789 there were no navy-yards. The public armed vessels that had figured in the Revolutionary war had been built at private shipyards. Indeed, from the time of the sale in Philadelphia in June, 1785, of the Alliance, the last ship of the Revolutionary period, to the launching of the United States (44), at the same port in May, 1797, an interval of twelve years, the country was without a navy.

The passage of the act of March 27, 1794, authorizing the construction of six frigates, was the first step towards the formation of the second, or present navy.

In regard to the construction of these frigates, the Secretary of War (who at that time administered the affairs of the navy) submitted to the House of Representatives a communication under

* From notes taken in the course of preparation of "Report of the Commission on Navy-yards, December 1, 1883."

date of December 29, 1794, in which he states that "the building of the ships has been directed in the several ports of the Union, in order, as well to distribute the advantages arising from the operation, as to ascertain at what places they can be executed to the greatest advantage, to wit: One thirty-six at Portsmouth, N. H.; one forty-four at Boston; one forty-four at New York; one forty-four at Philadelphia; one thirty-six at Baltimore, and one forty-four at Norfolk."

The sites on which these vessels were built belonged to private individuals.

Two years after (January 11, 1797), in a letter addressed to the chairman of the House "Committee for inquiring into the state of Naval Equipments," etc, etc., he states that "if Congress perceive advantages in the extension of their marine . . . it will be proper that authority be given to purchase a site for a navy-yard." In compliance with this recommendation the House committee on Naval Affairs on January 25 reported "as their opinion that a sum of money be appropriated for the purpose of purchasing and fitting up a naval yard." This recommendation, however, was not adopted by Congress.

In January, 1798, a committee of the House was appointed "to inquire into the expenditures of the moneys appropriated for a naval armament, and also into the causes of the delay in completing the same." In answer to the inquiries of this committee the Secretary justifies the wisdom of his predecessor in having all the ships built at the same time, and in different places, and adds: "The great delay that has occurred in the present undertaking must always be more or less experienced when heavy ships of war are required to be suddenly built, and the Government not previously possessed of the necessary materials. It is certainly an unfit time to look for these and prepare a navy-yard when the ships are required for actual service. . . . Do not these circumstances point to the expediency of legislative provisions commensurate to so important an object?"

Again on January 17, 1799, a committee of the House recommended that "for the safekeeping and careening of ships-of-war of the United States a dock or docks should be established in one or more places in the United States." But Congress again failed to adopt the recommendation.

Under date of April 25, 1800, the Secretary of the Navy (a

department of the navy having, in the meantime, been authorized by law) submitted for the consideration of the President a very strong appeal in favor of the purchase of sites for navy-yards. "No express provision," he remarks, "was made by Congress for establishing navy-yards for building the first six frigates directed by law. But as vessels so large cannot be built without first erecting wharves, or extending wharves before erected, both these things were done, and in every instance on private property; so that the public have now little or no advantage from the expenditure of sums to a considerable amount." Then follows a forcible argument showing the wasteful extravagance of the prevailing system. "In this view of the subject," he continues, "and believing that it is the truest economy to provide at once permanent yards, which shall be the public property, and which will always be worth to the public the money expended thereon, instead of pursuing the system at first adopted, which, with the experience before us, can only be justified on the ground that the ships now ordered are the last to be built by the United States, the Secretary of the Navy has had but little difficulty in making up his opinion that the proper course to be pursued is to make the building yards at Norfolk, Washington, New York and Portsmouth public property, and to commence them on a scale as if they were meant to be permanent; and also the building yards at Philadelphia and at Boston, notwithstanding the high prices which must be given for the ground."

Accompanying this paper is an elaborate report by Mr. Joshua Humphreys, Naval Constructor, and the designer of the new frigates—those of the Constitution class—on the various sites proposed for navy-yards.

In a letter from the Secretary of the Navy to the House Naval Committee on the naval establishment and its expenses, under date of January 12, 1801, after quoting the act authorizing the construction of the seventy-fours, he says: "Ground has been purchased at Portsmouth, N. H., Charlestown (near Boston), Philadelphia, Washington and Norfolk, and measures have been taken to procure ground at New York for capacious building and dockyards, and progress in making and preparing docks for receiving timber, and wharfs for building ships."

As nothing in the acts quoted authorized the purchase of sites for navy-yards, it will be seen that the Executive took the initia-

tive steps for the formation of a permanent naval establishment. This is explained in a communication to the House under date of December 8, 1801. "How far the authority given by the Legislature for procuring and establishing sites for naval purposes has been perfectly understood, and pursued in the execution, admits of some doubt. A statement of the expenses already incurred on that subject shall be laid before you. I have in certain cases suspended or slackened these expenditures, that the Legislature might determine whether so many yards are necessary as have been contemplated." Then follows a statement of

EXPENDITURES ON ACCOUNT OF NAVY-YARDS, DOCKS AND WHARFS, TO 1ST OCT., 1801, as follows:

Portsmouth, N. H.—Purchase of ground.....	$5,500	
Improvements	26,304	$31,804
Boston.—Purchase	40,000	
Improvements	3,643	43,643
New York.—Purchase.....	40,000	
Improvements	1,865	41,865
Philadelphia.—Purchase	37,000	
Improvements	1,636	38,636
Washington.—Purchase	4,000	
Improvements	54,683	58,683
Norfolk.—Purchase	12,000	
Improvements	14,275	26,275
	Total	$240,906

In 1802 a committee of the House to whom was referred "so much of the President's message as related to naval sites" reported that "prior to 4th March, 1801, the sum of $199,030.92 had been expended in purchasing navy-yards and making improvements upon them, *without any law authorizing the purchase, or any appropriation of money either for purchase or improvements.*" But in the body of the report it is stated that "On that day—March 3, 1801—it appears by the act making appropriations for six seventy-four-gun ships, and for *completing navy-yards, docks and wharfs*, the sum of $500,000 was appropriated."

From this it would appear that Congress had finally recognized the existence of the navy-yards by making an appropriation of

money for their maintenance. Hence from this date—March 3, 1801—the six navy-yards named may be considered as part of the permanent naval establishment.

Under date of January 20, 1802, the Secretary of the Navy writes to the chairman of the House Naval Committee: "Since I have been in office I have anxiously sought for all possible information respecting the navy-yards, but no satisfactory opinion has yet been formed with regard to the yards *that ought to be sold.* There is reason to believe that the site of the navy-yard at Philadelphia ought to be changed. There is an opinion entertained by some that the site of the yard at Portsmouth is not the best; and doubts have been expressed respecting the proper position of the yard at New York. . . .

"With respect to the contemplated improvements of the navy-yards . . . I have only to remark that from the reduced scale of the proposed appropriation the intended improvements must, in a great degree, be suspended. . . .

"If Congress should deem it necessary to sell any of the present navy-yards, or to purchase other situations, and a committee should be appointed to prepare a bill for such a purpose, I will with pleasure contribute my assistance." Thus early in the history of our navy was the question of the sale of navy-yards brought forward.

The doubts here expressed as to the wisdom of the selection of the several sites were reiterated later on. In his annual report of December 2, 1825, the Secretary of the Navy says that "*The experience of the Department and personal observation during the last year have entirely satisfied me that the greater part, if not the whole, of our navy-yards are badly located.*" The Secretary then proceeds to discuss the difficulties presented by the building arrangements at the navy-yards. "They have," he observes, "been improved by temporary expedients, and the buildings erected and arranged with reference only to existing necessities, and without regard to the future and growing wants of our navy. Many and serious evils have resulted; much public money has been unnecessarily expended, many losses sustained by the change, removal and alteration of the several erections; timber exposed to decay; stores requiring immense labor to deposit and preserve them; a much larger number of hands required to perform the work; unpleasant and sometimes injurious delays in

fitting out our vessels. It is a mortifying fact, yet there is no doubt of its truth, that one-third of the money expended at our yards has been lost from this cause. The remedy is manifest, and it is earnestly hoped that means may be provided to apply it. A commission of prudent and intelligent officers should be selected to examine minutely and carefully all our navy-yards, and to make a plan for each, suited to its location and the future wants of the service at it, prescribing the buildings which will be required and the location and character of each building, together with such improvements in the ground and form of the yard as will be most beneficial."

It will be seen from the foregoing that the sites of the six yards named were, with the exception of the one at Washington, determined by a process of "natural selection," as it were. That is to say, that having no public shipyards, the government naturally went to those places for setting up their first ships where ship-building formed one of the industries, and where skilled labor and the materials which entered into ship-building mostly abounded. Thus expediency controlled the selection of the sites of the navy-yards, and expediency has controlled their development.

How irregular soever the manner of doing it, the wisdom of thus early laying the foundation of a permanent naval establishment was soon to be justified. Our extreme weakness, in a military point of view, invited the aggressions which led to the war of 1812. By the superiority of the naval power of Great Britain most of our Atlantic ports were blockaded and a number of our ships-of-war were burnt to prevent them from falling into the hands of the enemy. But however inferior on the ocean, on the lakes we met our adversaries on equal terms. It was there that arose that contest of energy and enterprise in constructing ships out of the "raw material," and skill in fighting them afterwards, that reflected such great credit upon our national marine.

There were three lines of military operations in the north: that near the head of Lake Erie; the one on the Niagara frontier; and the one which had Lake Champlain for its base. On all three lines the successes gained by the American naval forces led to the most important results. As a direct consequence of Perry's victory on Lake Erie, the Northwest was relieved from invasion; Gen. Harrison's army enabled to advance into Canada;

the battle of the Thames fought, Tecumseh killed; the last great Indian combination broken up; and Detroit and the Michigan territory recovered. McDonough's victory on Lake Champlain ended the attempted invasion of northern New York and terminated the campaign of the English forces on that line; while Commodore Chauncey's brilliant successes on Lake Ontario caused the British to evacuate the whole Niagara frontier. The operations of war had therefore introduced new strategic points; and to the six navy-yards, at one time deemed an excessive number, there were added at the conclusion of the war of 1812 seven other naval stations, to wit: Whitehall, Lake Champlain; Sacketts Harbor, N. Y.; Erie, Pa.; Charleston, S. C.; Baltimore, Md.; Newport, R. I.; New Orleans, La.

In the same way the military operations during the Mexican war brought the navy-yard at Pensacola into active operation, and fully demonstrated the necessity of a naval station on the Gulf frontier; the acquisition of California required a navy-yard in the bay of San Francisco; while, during the late civil war, Port Royal, S. C., Mound City, Ill., and Key West, Fla., became, for the time being, the most important naval bases in the possession of the government.

The operations of the war of 1812 forced on the attention of the government the exposed position of some of the navy-yards on the Atlantic board. Under date of February 22, 1814, the Secretary of the Navy, in a communication addressed to the Senate, writes: "No further steps have been taken in relation to the dockyard [at New York] than general inquiry and proper deliberation in order to determine upon the best site in a central situation.

"The result has decided in favor of the right bank of the Hudson above the Highlands. The motives to this decision were from considering the contemplated dockyard as the nucleus around which a great naval establishment may be formed, comprising wet and dry docks, forges, foundries, boring, rolling, saw and block mills, blast and smelting furnaces. . . . Here also will be the main arsenal and depot of timber and materials of all kinds, and principal dockyard for constructing and repairing ships-of-war. Such an establishment in any of our seaports accessible to ships of the line, would form so great a temptation to a powerful enemy as to render destruction certain, unless pro-

tected by forts and garrisons of the most formidable and expensive nature."

These views were fully confirmed by the report of the mixed commission of 1820, which indicated Murderer's Creek, near Newbergh, N. Y., on the Hudson as the best site for a naval depot.

In compliance with a resolution of the U. S. Senate of February 13, 1817, and while the memories of the war of 1812 were still fresh, the President appointed a commission of army and navy officers to report on the "defense of the maritime frontier and the establishment of naval depots and dockyards." Commodore Bainbridge, one of the commissioners, in a minority report lays down the conditions necessary for the establishment of a "naval depot, rendezvous and dockyard," and then expresses the opinion that Boston "possesses in an eminent degree all the great advantages necessary for a naval establishment," concluding his report with the remark that "so extensive a coast as that of the United States requires at least three considerable naval arsenals. "Geographical situation appears to me to mark decidedly Boston, New York and Norfolk as the proper sites: Boston for the eastern section of the country, New York for the middle, and Norfolk for the southern."

The instructions to the commissioners, it should be observed, required an examination of the ports and harbors *east of the Delaware* and as far as Portland, Maine.

The majority report, signed by Gen. Swift of the Engineer Corps, U. S. Army, and Captains Evans and Perry of the Navy, states that "the positions presenting the most importance in respect of good harbors, depots and defensible sites, are to be found in the waters of the Chesapeake and Narragansett Bays." They then proceed: "The Commissioners (except one) are of the opinion that Narragansett Bay presents the best site for a naval depot in the Union north of Chesapeake Bay." They give their reasons in full for their preference.

Following this report came one in 1819, one in 1820 and one in 1821, all bearing on the subject of maritime defenses, and all exhibiting careful study of the whole subject from both the military and naval points of view.

The weight of authority unmistakably indicates a position remote from the seaboard as the best site for a great naval depot, as we have seen from the report indicating the upper Hudson in

one instance and the recommendation of "Burwell's Bay on the right bank of the James above Day's Point" by the joint commission of February, 1819.

In those days the calculations were based upon attacks made by wooden vessels propelled by the wind, the heaviest guns being 42 pdrs., having an effective range of 1½ miles; whereas to-day we must provide against ironclads carrying long-range guns of high power. What may be called the "working gun" of the leading naval powers is assumed to be the 8-inch rifled gun, throwing a projectile of 250 lbs. about eight (8) miles.

A single gun of the heaviest of the European ironclads will throw a greater weight of iron than the entire broadside of a line-of-battle ship of 1812. A seventy-four-gun ship of that period could throw at a broadside 1612 lbs. of metal; a forty-four of the Constitution class, 680 lbs., whereas a single projectile of the Italian Duilio weighs about 2000 lbs.*

If, then, some of our navy-yards were, in the days of short-range guns, thought to be in dangerous proximity to the sea, what shall we say of them now when powerful ironclads can, from the open coast, hurl huge masses of iron for a distance of five or six miles or more, according to the elevation obtainable? If to this we add the defenseless state of our principal harbors and the water approaches to our navy-yards, as clearly set forth by our military authorities, their exposed positions may be fully understood.

The reason why the New York navy-yard, taking that as an example, was not sent up the Hudson beyond West Point, to ensure its safety, seems very plain.

As early as 1798 the Secretary of the Navy recommended in an earnest and well argued report the building of 12 line-of-battle ships of 74 guns each, and as many frigates, with 20 or 30 vessels of smaller ratings. This was to establish the outer line of coast defense and furnish the desired security. The frames of 11 line-of-battle ships were actually set up, but the majority of them were permitted to rot away on the stocks. Congress would neither grant the money necessary to complete them, nor the complement of seamen necessary to man those that had been launched. But four of them ever got to sea; that is, in the sense of making a cruise.

*The extreme range of the 100-ton gun is, by calculation, 13½ miles. A range of from 7 to 10 miles may in practice be counted upon.

Successive administrations finding that, despite the lessons of the war of 1812, Congress was not disposed to augment the navy and coast fortifications to the extent requisite for defensive purposes, felt the necessity of providing for the safety of the navy-yards by throwing them back from the coast and beyond the reach of a sudden attack by a hostile force.

But accessibility from the sea to our own ships is one of the most important considerations in determining the relative values of a site for a navy-yard. It was believed, moreover, that in due time the people of the United States would become convinced of the fact, and so express themselves through their representatives in Congress, that the great centres of commerce on our seaboard (and the navy-yards included within their limits), together with our vast coasting trade, demanded the protection which a fleet of line-of-battle ships and forts alone could render. Under the influence of this conviction the navy-yards on the Atlantic coast were allowed to remain where originally located. They must necessarily, it was argued, receive the protection imperatively demanded by the centres of wealth and commerce of which they form part.

The question "How many line-of-battle ships to supplement the maritime defenses should the United States possess, in order to afford this protection?" is only to be determined after careful study of all the conditions, past, present and prospective, of the problem. But if the Secretary of the Navy found good and ample reason in 1798 for recommending 12 line-of-battle ships, a recommendation Congress tacitly adopted, it is not too much to say that in 1898 we should have at least 18 line-of-battle ships; and frigates or cruisers, and other classes of ships, in proportion.

The more precise term *line-of-battle ship* is used here rather than the modern but indefinite term *battle-ship*. Any vessel, armed and equipped for fighting, may be called a battle-ship. The Petrel, carrying four small guns, was designed for battle, but she would hardly be admitted as part of a fleet composed of such ships as the Indiana and Iowa, ships representing the highest military value. The same may be predicated of the monitor Puritan. Though possessed of great power as a fighting machine, she is deficient in the manœuvring qualities requisite to fleet evolutions: her rôle is a restricted one. Hence the naval tactician must arbitrarily assume certain classes of vessels that, with the

requisite manœuvring qualities, can stand, with reasonable chances of success, the shock of battle between opposing fleets, and assign them to the force that is to constitute the line of battle. During the sail period it was generally understood that the 60-gun ship should be the smallest vessel admitted to the line of battle. The naval tactician of to-day requires that there shall be a certain measure of homogeneity in the ships that are to compose the main body of the fleet with which he may be called upon to guard our coasts and navy-yards. In other words, his line of battle must be composed of line-of-battle ships.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE WAR IN THE EAST.

By Captain Richard Wallach, U. S. Marines.

INTRODUCTION.

By Captain H. C. Taylor, U. S. Navy, President of the U. S. Naval War College.

The war between China and Japan began at a moment when the War College was engaged upon problems of naval campaigns. Some officers had already taken up, as an example of strategic principles, a situation based upon hostilities between those nations, with Corea as a theater of operations. It was natural therefore that actual war coming at such a time should engross much of the attention of the officers in attendance during the session of 1894. At the close of the war I requested Captain Wallach, of the permanent staff of the College, to embody in a series of lectures the military operations of the Chinese and Japanese forces and his commentaries thereon. These lectures were read during the session of 1895, and his method of treating the subject proved so interesting that the Naval Institute invited him to publish them under its auspices.

The special value of Captain Wallach's work lies in the comparisons which his historical studies enabled him to draw between the Japanese campaigns and those of former wars, by means of which each military operation is classified with those in history among which it properly belongs. In the pursuit of knowledge we find little satisfaction in the contemplation of an isolated fact. It is only after many facts of like qualities are gathered into a homogeneous group that we begin to discover those threads of truth with which alone we may weave the fabric of a sound philosophy. Captain Wallach's study of the war in the East classifies the data at hand, and moves forward another step in the military art by assigning the operations at Ping Yang and elsewhere their due relation to certain campaigns of Frederick and other leaders. His work is therefore something more than a correct narrative of military events, and will claim the attention of officers on account of its interesting analogies, by means of which we discern more clearly the principles of success and failure, however different may be the military situations which they dominate.

H. C. Taylor.

The narrative of events contained in these lectures was prepared from various reports from the seat of war, chiefly those published in the Army and Navy Gazette, London, and the New York Herald.

The following works were also consulted and drawn upon, viz.:

The Comte de Paris' History of the civil war in America, Jomini's Art of war, Mercur's Art of war, Soady's Lessons of war, Hamley's Operations of war, Derrécagaix's Modern war, Hozier's Seven weeks' war, German official account of the Franco-German war 1870-71, Dufour's Strategy and tactics, Brackenbury's Field fortifications, Greene's Russian army and its campaigns in Turkey in 1877-78, Johnston's Narrative, James' Modern strategy, in United Service Magazine, Fix's Manual of strategy, Cust's Annals of the wars of the 18th century, Jomini's Life of Napoleon, Von der Goltz's Nation in arms, D'Armit's Intrenched camps, in Journal Military Service Institution, Dodge's Cæsar, Colomb's Naval warfare, Colomb's Essays on naval defense.

Operations of the First Japanese Army.

In June, 1894, China landed a force of 2000 men at Asan to quell disorders which had assumed such proportions as to be beyond the control of the Corean government. This force was unable to move for a considerable time through lack of preparation for a campaign.

As soon as the Japanese government learned of this step it promptly despatched a force of from 4000 to 5000 men to Chemulpo under convoy of several warships. These troops occupied Seoul without opposition, and cut off the lesser Chinese force from its own frontier and the possibility of succor from that direction. On the other hand, should China continue to throw troops into Corea by way of Asan, there confronted Japan the danger of having its troops hemmed in between two superior forces, since in an invasion of Corea the great mass of Chinese troops would enter it from the north. This danger, however, was averted by the Japanese continuing to pour in troops by way of Chemulpo until their force was self-sustaining. The Kowshing disaster also rendered it highly improbable that Chinese reinforcements would be sent over sea until the command of that element had been secured. During July 27 and 28 several actions occurred in the vicinity of Asan, where the Chinese were attacked in superior numbers. In one of these actions, during a night attack two Japanese divisions fired into each other, doing much damage. The Chinese admit that of the 1500 men lost

by their enemy, by far the greater portion fell from their own fire. While the Chinese camp was cut to pieces, the major portion of the troops succeeded in cutting their way through the attackers' lines, retreating to Yoju and escaping to the northward and eastward of Seoul. Keeping to the mountains they eventually, after 26 days of more or less fighting, joined the main body of Chinese encamped at Ping Yang.

This was unquestionably a clever piece of work, as the only avenue of escape was by passing to the eastward of the Japanese force near Seoul, the moral effect of the sinking of the Kowshing leaving little hope of being reinforced by troops from over the sea. The Japanese being in much greater force, their failure to intercept the Chinese can only be accounted for on the ground that they regarded an attempt to march from Asan to Ping Yang, a distance of 200 miles, through such difficult country, as hopeless. For several weeks subsequent to the actions about Asan, a series of combats and affairs between outposts and advance guards took place, the result of the Japanese advance northward.

In the early part of September the Chinese main force occupied a naturally strong position at Ping Yang on the Tatong River, which they had further strengthened with intrenchments, throwing forward advanced posts in the direction of Seoul.

The Japanese, owing to the criminal inertness* of the enemy's fleet, had been landing troops unmolested under cover of their cruisers at Gensan on the east coast of Corea, at Chemulpo, and at Hwangju, at the mouth of the Tatong River. This last force the Chinese General Yeh, the same who escaped from Asan, claimed to have destroyed, but as these troops, reinforced by marines and seamen from the fleet, performed such efficient service at the battle of Ping Yang, his statement was apocryphal.

The Japanese converged upon Ping Yang in three columns: the first from Gensan, the second from Seoul, and the third from Hwangju. The paths over the mountains from Gensan were believed to be impracticable for a force of any considerable size, and no great apprehension was felt in this direction by the Chinese, yet the arrival of these troops upon the field with such admirable punctuality demonstrates the skill with which they surmounted all

*Later information shows that the non-interference of the Chinese fleet was due to orders from the Tsung Li Yamen restricting its cruising limits, and not to its commander.

difficulties, and reminds us of General Gourko's march over the Balkans in 1877.

By the night of Friday, September 14, the three Japanese columns were in position for a combined attack, and each in touch with the others. The first, or Gensan column, advancing from the northward, lay in rear of the stronghold; the second, or Seoul column, composed of several divisions, threatened it from the eastward; while the third, or Hwangju column, approaching from the westward, lay in front of the works south of the town.

Ping Yang, itself a natural stronghold, had been added to by the construction of a series of earthworks with modern armaments and manned by China's finest troops. In the main fort, or castle, close to the city gates, there were three Krupp field pieces and several Gatling guns, while all the troops carried Spencer or Mauser rifles, and there was no lack of ammunition. There were one or more field pieces and several Gatling guns in each earthwork and masked fort. Altogether the Chinese troops were intrenched at twenty-five different points, and besides the main castle there were five other large and well-armed forts,—two to the south and one to the north of the city and main castle, and two on the banks of the river opposite the city. The masked fort to the northward of the castle is reported to have been the best piece of military engineering ever accomplished by the Chinese. These forts were supplemented by numerous fieldworks. On the banks of the river opposite the city, on a hillside among the pine-trees, were two forts, flanked by two fieldworks, with two more in advance.

It was against these works that the Chinese expected the attack would be made, and had gathered there in greatest force. The Seoul column advancing in this direction had been reinforced by another detachment from the south, and was under the command of Major General Oshima, who began the fight by opening fire with his artillery at daybreak on Saturday, September 15, continuing the bombardment until after noon; the Chinese, whose position in this quarter was recognized as exceptionally strong, replying with a brisk cannonade. At 2 p. m. the Japanese infantry advanced, making a feint attack, and under a combined artillery and rifle fire succeeded in capturing the advanced positions, and discovered that the works in rear had suffered considerably from the bombardment. Desultory firing continued

during the night with a view to fixing the attention of the defenders in this direction. This proved so successful that the first and third columns were enabled to close in on the rear and right flank to within 100 yards of the works, the Chinese remaining in ignorance of these movements until the real attack commenced at 3 o'clock on the following morning.

The combined attack of these three forces was executed with perfect precision and regularity. The Seoul column advanced against the hillside forts, but were received with such an effective fire from the Krupp and Gatling guns as to cause the commander of the attacking troops quickly to divide his detachment into two wings. As the Japanese troops neared the works the Chinese fire ceased, but when they reached the walls of the fort the defenders made a desperate charge, and a terrible hand-to-hand conflict ensued, in which the Japanese killed fifty of their adversaries with the bayonet at one spot alone, while the rest of the garrison fled, leaving the Japanese in possession of the works. This occurred at 7 o'clock in the morning. In the meantime a cold drizzling rain set in, increasing to a steady downpour later in the day, adding greatly to the discomfort of the attacking forces. By this time the second wing of the Gensan column had captured a hill commanding the works north of the castle. Placing their fieldpieces upon the crest of this hill, they made the works below untenable, throwing their garrison into a panic and causing them to retreat toward the castle and city in confusion. The western column, in two wings, began the advance against the earthworks and forts to the east at 5 a. m., capturing them by 9 o'clock. The Japanese were thus in possession of all the works outside of Ping Yang with the exception of the castle. Several assaults were made against the gates of the castle, but the resistance at these points was most desperate, and it was after 2 p. m. when the victorious troops, almost worn out from the long-continued fighting and their ammunition well-nigh exhausted, finally occupied the castle and city.

The victory was decisive, the Chinese being dispersed and routed in all directions. The victors claim to have killed 2500 and captured 14,500, among the latter the commander-in-chief and three other generals. They also captured large quantities of equipments, provisions, arms and ammunition, with hundreds of colors. The Japanese reports state that the Chinese defended the

position with 20,000 troops, and admit that they outnumbered the Chinese nearly three to one. The Japanese loss was estimated at 30 killed and 270 wounded, including 11 officers.

The concentration and attack on Ping Yang illustrate the successful execution of two of the most difficult and hazardous operations known to military science, requiring ability of the highest order. These are the combined march and the night attack.

Combined marches are generally understood to be those in which two or more armies operating upon separate lines from distant bases, or the corps of a single army marching over separate roads, arrive from two or more directions upon a position occupied by an enemy. There is nothing more influenced by chance than these simultaneous movements; the smallest accident may cause their failure and disarrange the most perfectly laid plans; a body of troops may be led astray by the guide, bad roads may retard the march, streams swollen from a storm may arrest a column, an enterprising enemy may attack one of the detachments, indeed any number of accidents may happen, rendering the operation abortive. The greater the extent of these concentric movements the more they are exposed to chance. There is an inherent element of danger, increasing with the distance separating the forces. Such movements are always attractive from the possibility of enveloping an enemy outweighing the chances of having one of the enveloping detachments beaten before the junction is completed.

This happened four times to the Austrian army between July, 1796, and February, 1797. Four times within this period the Austrians advanced simultaneously into Italy for the relief of Mantua, besieged by Napoleon, who, concentrating his forces in a central position, twice beat in succession the separated corps of Marshal Wurmser, and twice those of Lieutenant General Alvinzi, gaining from the former the victories of Lonato and Castiglione, and from the latter the still more important and celebrated victories of Arcola and Rivoli. The last-mentioned victory resulted in the dispersion of the veteran army of the Empire, the abandonment of further efforts for the relief of Mantua, and the transfer of the young Archduke Charles from the field of his successes in Germany to the theater of operations in northern Italy. Again, when France became the theater of

war, Napoleon gave striking evidence of the effectiveness of such strategy. For four months he opposed triple his forces, fighting a battle in one place one day, the next marching 25 or 30 miles to attack another enemy. In February, 1814, Napoleon, after beating in detail, with 25,000 men, the four separate detachments comprising the army of Silesia under Blücher, aggregating 60,000, which extended along the Marne River, threatening Paris from the east, and only about 25 miles from it, drove Blücher back upon Chalons. Leaving Marmont with 10,000 men to guard the approaches to Paris from that direction, he lands like a thunderbolt upon the theater of operations of the Grand Allied Army advancing upon Paris from the south, along the Seine. The Grand Army numbered over 100,000, whilst Napoleon's had increased to 30,000 during his march by picking up detachments *en route*. By surprises and attacks upon detached corps, advance guards, etc., he forces the enemy back, who thus forms a junction with Blücher. Napoleon says: "I expected that the allies would profit by the union of such large forces to offer me a decisive battle . . . but to my great astonishment they did nothing, and continued their retreat." Referring to these operations, he says he was convinced that it was only by extreme activity that he could compensate for his great inferiority of numbers. He also says of this march to the Seine: "The cavalry marched night and day; the infantry travelled *en poste*. In this way we made 36 leagues in 36 hours."

Cæsar, when surrounded in Gaul by nations in insurrection, extricated himself from his critical position by similar movements. He gave the Gauls neither time nor means to unite: he fought them successively and beat them in detail.

Napoleon said: "When the conquest of a country is undertaken by two or three armies, each of which has its separate line of operation until they arrive at a point fixed for their concentration, it should be laid down as a principle that their junction should never take place near the enemy, because the enemy by uniting his forces not only may prevent it, but beat them in detail."

Notwithstanding this maxim, the campaign of Waterloo, 1815, which closed the career of this wonderful soldier, opened with the concentration of the widely separated corps of his army upon the field in the presence of the enemy,—an operation attended with

such brilliant success as to call forth the highest praise from Jomini. Of it he says (writing as if in the words of Napoleon):

"The plan and commencement of this campaign form one of the most remarkable operations of my life (Napoleon's). Nine corps of infantry and cavalry cantoned from Lille to Metz, by marches most skillfully concealed, concentrated before Charleroi at the very instant that the guard arrived there from Paris. These movements were combined with so much precision that 120,000 men found themselves assembled, the 14th of July, on the Sambre, as if by enchantment. Wellington, occupied in giving fêtes at Brussels, thought me at Paris at the moment that my columns presented themselves on the morning of the 15th to cross the Sambre. So little idea had my enemies of these movements that their armies were not even assembled."

He says that if the allies' generals allowed themselves to be surprised, it must be admitted that they had made their preparations with skill, and admits that to prevent Napoleon from manœuvring to separate their armies, wise dispositions had been made and all rallying points well indicated. "But," he says, "wise as these dispositions were, the celerity and impetuosity of my movements might defeat them." Of the concentration of Blücher's corps upon these rallying points he says: "These movements were evidently based on information received from deserters." Denying this statement, Lieutenant General Cust, British army, says Wellington had "consequently well studied his adversary's last campaign of 1814, when he so successfully separated the Prussian and Austrian armies, and had carefully considered the means of thwarting that favorite manœuver of the French conqueror." In the execution of that manœuver Napoleon was excelled by Cæsar alone.

Now as the advance of the Japanese columns was over widely separated lines of operation from distant points, and as their junction took place upon the battlefield, in the immediate presence of the enemy, we must regard it as a violation of a principle of strategy as set forth by Napoleon.

In the Austro-Prussian war of 1866 several divisions from widely distant bases advanced simultaneously into Hanover and Hesse Cassel. These combined marches were executed with such consummate skill and punctuality that the Hanoverian army

was paralyzed, and large quantities of stores, munitions and guns captured.

The army of the Elbe under General Herwarth was to invade Saxony from the north (Torgau) in conjunction with the advance of the first army under Prince Frederick Charles from the east (Gorlitz). This simultaneous movement was also made with such precision and celerity that the King with his court had barely time to quit Dresden before the combined columns entered the city. Prince Frederick Charles gathered his army together about Gorlitz for the advance into Bohemia simultaneously with that of the army of the Elbe, with which he formed a junction near the Iser River, and the second army under the Crown Prince from Glatz. The concentration of the first and second armies took place upon the field of Königgratz, the army of the Elbe striking the left of the Austrian position, the first army the center, and the second army the right and rear, throwing the Austrians back upon Königgratz in confusion. In the Prussian advance upon Königgratz the first and second armies, advancing over different lines from Gorlitz and Glatz respectively, were separated by an impassable mountain barrier for several days, and on issuing into Bohemia either might have been confronted by a superior army before the concentration of the two armies was effected.

We may set this down as another violation of a principle of Napoleon's strategy. But we may also see in it the birth of Von Moltke's strategy—or rather the principles of strategy as applied by him—brought about by the immense size of modern armies, the facility of communication by means of the railroad, by which alone it is possible to keep these immense armies supplied, and the constant supply of information through the telegraph. Those lightning-like movements of Napoleon's armies from one part of the theater of war to another would have been impossible with the huge masses of to-day. In the days of Napoleon it required a constant interchange of couriers, orderly officers, or aids, between the general headquarters and the several corps, in order that, on the one hand, the chief of staff who prepares the orders of march may be constantly informed how they are carried out, and may communicate to the commanding general the real condition of affairs at any moment; and on the other hand, that the commanders

of corps may be kept acquainted with passing events, and instructed as to the necessary modifications of details in carrying out the main plan. All this is now accomplished by means of the telegraph. Forces hundreds of miles apart can now be kept in constant communication with a single directing head, and their movements regulated with the precision and punctuality of the parade ground.

Von Moltke in replying to certain criticism on his strategy in uniting the two Prussian armies on the field of Königgratz said: "Armies are now so large that unless you are willing to reduce war to a mere hammer-and-tongs affair, you must have combinations of this kind; it is not possible to have such striking results unless you do bring about these combinations on the actual battlefield; for, if you bring them to pass before the battle, the enemy is likely to know just as much about it as you do; whereas forces which are moving on exterior lines can now be united by the telegraph, and moved with just as much certainty, so far as direction is concerned, as if they were really under the same commander." In Königgratz and Ping Yang we have striking examples of how great and far-reaching may be the effects of such a combination; and it is claimed that in future it will be one of the resources of the great general to bring about, unknown to his enemy, combination of forces from different points which will unite on the battlefield for a common object.

While the telegraph has greatly facilitated these simultaneous movements, it has increased the possibility of failure through interruption of the lines connecting the several forces with each other and with the central authority. In the combined march upon Königgratz, telegraphic communication between the two armies was not maintained up to their junction; had it been, their joint attack might have been so timed as to obviate the risk of separate defeat which the premature onset of the first army entailed. Had the Austrians developed their whole power against the seventh division under General Fransecki, which was exposed across the Bistritz, separated by a wide interval from the nearest division, the result would have had a marked effect upon the battle. This division, engaged since 8 in the morning against the enemy's constantly increasing masses, about 11 o'clock found itself in presence of 51 battalions

and more than 100 guns without being able to count upon outside support. Its center first gave way, and the danger of having its wings separated appeared. In this critical position Fransecki vainly called for support. Recognizing the importance of the point occupied, he inspired his officers and troops to defend the position to the last extremity, and by their stubbornness held out until the welcome cry of "The Crown Prince is coming" rang out through the thinned ranks and reanimated the exhausted defenders. This simultaneous advance, although directed by the greatest strategist of our day, who pronounced such movements necessary under present conditions, would probably have had disastrous results had it been made against a more competent general than Marshal Benedek, and convinces us of the danger inseparable from such operations.

In this connection, however, we must bear in mind that circumstances, which are always different, must decide in each particular case that arises; for what is the right thing in one case may be injudicious in another. The course to be followed is greatly influenced by the character and capacity of the opposing generals, the quality of the troops, their armament, state of discipline, etc. In 1654 Turenne passed before the Spanish lines within range, thereby losing several men, which occasioned remark among the officers of his staff who accompanied him. His answer was: "It is true, this movement would be imprudent if made in the presence of Condé, but I desire to examine this position closely, and I know the customs of the Spanish service are such that before the Archduke is informed of our proceedings, has given notice of them to Prince Condé and received his advice, I shall be back in my camp." To make these delicate distinctions and do the right thing at the right time, in the right place, is a manifestation of a true genius for war.

It is fair to assume that the Japanese commander was fully alive to the risk attendant upon his movements if attempted against an active and enterprising enemy, but in this particular case the risk was minimized by the failure of the Chinese to recognize the necessity of the employment of those covering detachments which provide security for their own force as well as information regarding the enemy. The Japanese columns are said to have been in constant communication with each other through the field telegraph, and the intelligent manner in which they per-

formed their patrol and reconnoitring duties kept them well informed of the strength and dispositions of the enemy.

In the Königgratz campaign we find also a wide difference in the practice of the two armies in providing security and information. The Austrian system was much inferior to the Prussian, said to be due chiefly to the want of military education on the part of the officers to whom patrols were intrusted. The Prussian system never failed, never allowed a surprise, while the Austrians were repeatedly surprised and taken unprepared. A Prussian officer on a scout approached the gates of Königgratz on the evening of the battle without meeting a single Austrian and boldly entered the place, where he was captured. With a ready resource he informed his captors that he had come to demand the surrender of the town, which demand was courteously refused by the Austrian commander, who had him escorted beyond the lines without even asking if he was an accredited representative. At the battle of Königgratz the Prussian Guards entered Chlum, established themselves on the Austrian flank under cover of a mist and caused defeat. As a matter of fact the troops of the Crown Prince did not fall in with a single patrol till they actually came into collision with the Austrian line of battle. This same activity in scouting duties is noticeable on the part of the Germans in the war of 1870: the French were unable to shake off the touch of the ubiquitous Uhlan watching their movements.

The Japanese have proved themselves worthy pupils of their masters in this direction, and their great success at Ping Yang, as well as at other points, was contributed to in no small measure by the efficiency of their intelligence department and patrol system. Their intelligence department was provided with accurate maps of the country, with all the roads excellently described, with the passages of the rivers, and their width and varying depths recorded with such exactitude as to enable them to adjust their pontoon trains to precisely the width of each of the rivers it would be necessary for them to cross.

Napoleon says: "Every general who operates not in a desert but in an inhabited country, and yet obtains no information, does not know his trade. The greatest military talent is useless if one is not perfectly instructed as to all the movements of the enemy. The faculty of organizing a system of intelligence is a remarkable quality, and requires a profound knowledge of human nature."

The Japanese had also a well organized and equipped field telegraph detachment, and history does not afford us a better example of the capabilities of this useful appliance when intelligently employed. Within ten hours of the capture of Ping Yang the line was established some distance to the rear, a message flashed over it to the Emperor informing him of the victory, and a reply received congratulating the army upon its success.

Ping Yang stood an obstacle to the further advance of the Japanese as Plevna did to that of the Russians in 1877, but what a marked difference in the result! The Russians stumbled without warning upon a force four times as strong as their own, in a position like Ping Yang, naturally strong, increased by intrenchments, and received the first check to a series of brilliant victories, the moral effect of which was very great upon both belligerents. This crushing defeat occurred on July 20, and brought the Russian advance to a halt. Although two bloody assaults were subsequently made, it was necessary to resort to siege operations, after having called out over 300,000 more Russian troops and appealed to the Prince of Roumania to place his army of 50,000 men in the field. The entire Russian empire was paralyzed from the date of the first collision till the date of capitulation, December 10. The battles up to that date cost the Russians 40,000 men. One of the great objects of the art of war is to be stronger than your enemy at the right time and at the right place. In this particular Ping Yang was a brilliant success, Plevna a disastrous failure. While the Russians could not have scored such a victory as Ping Yang, had they possessed an intelligence department equal to the Japanese and been as proficient in their patrol and reconnoitring duty, they would at least have been spared a crushing and humiliating defeat.

How different might have been the result of the concentration upon Ping Yang had the Chinese been informed of the strength and movements of the Japanese columns. We have seen that the Chinese had 20,000 men, and that the Japanese admitted they greatly outnumbered their enemy. We have also seen that the second, or Seoul, column was the strongest; the other two columns most probably were each less than 20,000, and as the advance of the Gensan column was through such difficult country, by mere bridle paths over the mountains, it is quite probable it was weaker than the Hwangju

column, and therefore much weaker than the Chinese force.* With that intelligence of their enemy which they should have possessed, it was possible for them to have received the Japanese as they debouched from the mountain passes, crushing the head of the column as it appeared. Of course this would have precluded any defense of Ping Yang, for we have seen the sound strategy of the Japanese provided for the arrival of the strongest column first, in front of the position, which would have been found empty; nevertheless this would have been far better than the crushing defeat suffered without injury to the victors. The defeat of one of the Japanese detachments would have been a severe blow to their prestige and a needed addition to their own, which was at a very low ebb.

Long experience has shown that the concentrated action of large masses of troops upon a battlefield is impossible at night, and that attempts to continue a general engagement after dark result in confusion, loss of direction, and general disorganization and demoralization of the different units of an army.† The great range and destructive effect of modern firearms have caused the advance of a hostile line from extreme to moderate ranges to be accompanied by such great losses that attention has been strongly directed to the practicability of advancing lines of battle to within short distances of the defensive position under cover of darkness. After the Russo-Turkish war of 1877, which gave us many examples of night fighting, the Russians applied much thought and study to this subject, and the question was debated generally in European military circles. The events in Corea have revived discussion, which is carried on in tactical manuals, setting forth the pros and cons, and submitting regulations which should govern both the attack and the defense.

One of the most remarkable illustrations of a night attack is that upon the formidable fortress of Kars, armed with 300 guns and defended by 25,000 Turks, which was carried, with incon-

* A Japanese writer claims that they were a very little stronger than the Chinese at Ping Yang, and that the Gensan column numbered only about 1500 infantry with 2 guns.

† An English officer, as a result of observations during the Franco-German war, said: "The nation that first so trains its army during peace as to move and attack with relative facility by night will gain an advantage, which in future warfare will be decisive."

siderable loss, by a midnight assault. Tel-el-Kebir follows next as an example, in which the necessary conditions, as set forth by modern writers,—highly trained troops, well-understood plan, and a knowledge of the enemy's position—existed; and although the assaulting columns were composed of such splendid troops as the brigade of guards, royal marines, and in fact England's crack regiments, and the advance was made without noise or firing a shot, two columns almost came in collision, though the leading was as good as it could possibly be.

The Japanese commander appreciated the requisites of a successful night assault. He had a sufficient knowledge of the position, had established perfect communication between his columns, his troops were under admirable discipline and ably led, and the real attack was made unexpectedly and decisively,—the result of such an uncommonly favorable combination being a victory more decisive than either of the two just cited. Ping Yang stands out a masterpiece of modern warfare. Indeed, the night operations of the Japanese have caused military experts to assert more boldly that in the next war protection will be sought in darkness to bring troops up closer to fortified positions, and that night operations and night fighting will be resorted to on a much larger scale than ever before; and it is therefore urgently recommended that a complete system of regulations for attack and defense be formulated and practiced assiduously.

During the month following the battle of Ping Yang the Japanese drove the Chinese across the Yalu River, occupying Wiju, where they waited the arrival of their siege guns, while their adversaries worked day and night strengthening their works on the north bank of the Yalu. Detailed information brought in by the Japanese patrols showed that these defenses were not so strong as first reports indicated, and led the commanding general to believe that the main opposition would be encountered at Kiu Lien Cheng, 30 miles west of the Yalu and 120 from Moukden, which prediction proved to be correct.

A detachment of 1600 infantry from the main body crossed the river above the Sukochin ferry north of Wiju, turning the defenses at that point, and attacking them in rear expelled the defenders, who abandoned everything and fled down the river, only firing a few rounds. The detachment occupied the

works commanding the ferry, and with the assistance of the light draft vessels of the fleet, which now entered the river, covered the passage of the main body, which was completed and the army in position before Kiu Lien Cheng by early morning of October 26. The tactics so effective at Ping Yang were again resorted to, the advance at daylight being in four columns for a combined attack, but notwithstanding that the city was strongly fortified and garrisoned by 16,000 troops, the Japanese scouts found it empty. 30 guns, a large quantity of ammunition, rice and fodder, and 300 tents thus fell into the hands of the victors.

Detachments made to effect a diversion or a combined march, or for any other motive, are condemned by those writers on the art of war whose rules have been deduced from a study of the campaigns of the great commanders of earlier times. Conclusions are drawn from such experiences as the following:

The Great Frederick in 1759, near Dresden, detached General Fink with 18,000 men to cut the communications of the Austrian army with Bohemia. Fink succeeded in getting in rear of the Austrians, closing the way, but being too weak to hold it, was surrounded and fell into the enemy's hands, although he fought bravely triple his numbers, constantly hoping the army would come to his rescue, but the army was in ignorance of his peril and failed to do so.

Napoleon, upon nearly the same ground in 1813, detached Vandamme's corps after the battle of Dresden for an advance into Bohemia, the main body of the French army being still in the vicinity of Dresden. This detachment experienced at Culm the same fate as that of Fink, except that Vandamme attempted to break through the enemy's line and a part of his corps escaped. This operation cost Napoleon 10,000 or 12,000 excellent troops, and also affected very sensibly the morale of his army through the check it received.

Again, during our war of secession in 1861 General Lyon, confronting a greatly superior enemy, detached Sigel's brigade with two batteries—1420 men, forming a fourth of his command—for an attack upon his adversary's rear, at the battle of Wilson's Creek, in southwestern Missouri. Although Sigel arrived upon the field without mishap and joined in the battle, he was not in communication or within supporting distance of the main force, and his column was completely crushed and dispersed.

According to the maxim of these writers that detachments are dangerous, especially on the eve of battle, which holds good to a certain extent to-day, the Japanese commander was guilty of another violation of the principles of war when he detached 1600 infantry across the river to turn the defenses at the ferry. All the same, the movement breathed the spirit of modern strategy as set forth by the best writers of to-day. Hamley, for instance, in his admirable "Operations of war," says: "In the case of attempting to dislodge an enemy by sending a detachment round his rear, the telegraph will both diminish the risk of the movement and increase the chances of gaining its complete results." It is true the river separated this detachment from its main body, but with the first step in pursuit of it by the Chinese, the Japanese would have thrown their bridges, already adjusted, across the river and fallen upon their rear before they could have struck a blow, for there is no doubt the Japanese detachment was in constant communication with headquarters.

After the capture of Kiu Lien Cheng the Japanese army was divided into two columns. The right marched by Feng Huang Cheng, where it captured 55 guns, 1500 muskets, and large quantities of ammunition and general stores, through the Motien Pass to the vicinity of Liao Yang, driving the Chinese before it in the direction of Moukden. The left column marched upon Siu Yen by way of Taku Shan and drove the Chinese through Haicheng toward Liao Yang. On December 17 these Chinese troops were reported by the outposts of the right column, whose commander decided to intercept them in their march toward Moukden. He overtook them on the morning of the 19th at a small village, when they forced some fierce fighting upon the Japanese, and being some 10,000 strong, the position of the Japanese was becoming desperate when a brigade of the left column came up from Haicheng, securing a victory after five hours of the hottest fighting the first army had yet experienced. After this action Moukden was given up as an objective, and a junction was formed with the second army after it had captured Kaiping, on January 10, 1895. Niuchwang, where was massed a large number of troops, now became the objective of the combined armies.

Operations of the Second Japanese Army.

The second Japanese army, estimated at 30,000 men, including coolies, sailed with sealed orders from Hiroshima under Field Marshal Count Oyama about October 17. This force, in 38 transports provided with 400 small boats and lighters, 100 steam launches and 8 light draft tugs, rendezvoused at the mouth of the Tatong River, which point it reached on October 23, and was there joined by the fleet of 25 warships and 16 torpedo-boats. On the morning of the 24th the fleet sailed, followed by 12 transports, the remainder of the transports following that evening. Upon the arrival of the commander-in-chief on the Chinese coast with the main body the following morning, he found that the commander of the advance guard had already landed a part of his infantry, not a Chinaman being in sight. The point selected as the landing-place was a village on the Chinese coast, just north of the Elliott group of islands and about 85 miles to the northward of Port Arthur, the objective of the army.

With the exception of Talien Bay, close to Port Arthur, there was not a decent landing-place on the coast. It was impossible to land at Talien Bay, the Chinese having fortified the coast and laid down submarine mines. This selection was made not because the place afforded any great facilities for landing, but because the road from Wiju to Port Arthur passed nearer the coast there than elsewhere.

The landing was most difficult, the water being so shallow that the steamers had to anchor 4 or 5 miles from the shore. At low tide it was absolutely impossible to land at all, as the sea uncovered a mile and a half of mud. The difficulty of landing 30,000 men, horses, guns, ammunition, wagons, provisions, tents, ambulances—in short, that vast bulk constituting the equipment of a perfectly appointed expedition—under such conditions, I think all officers can appreciate. Using the tide, however, the landing was accomplished in an expeditious manner without the loss of a man. The only accident attending this operation—recognized as one of the most difficult in war—was the destruction by fire of a transport having on board the ammunition and horses of the siege mortars, just as it was about to unload. The ammunition and horses were all lost. The advance on Port

Arthur was begun at once, the army marching in two columns, the right consisting of the first division, the left of the second division.

On the morning of November 6 the first division attacked Kinchow, which was defended by some 1200 infantry and artillery. The guns were poorly served, their firing being weak and badly directed. The outlying works were quickly cleared and panic seized the troops in the inner forts, who fled in disorder, abandoning their guns, standards, and stores, and throwing away their rifles. The first division then joined the second in investing Talien Wan on the opposite coast. This strong position was defended by six forts mounting 80 guns of various patterns. On the evening of November 6 the bombardment of the Chinese position commenced, and on the 7th the works were carried by assault, the garrison of 3000 offering but a slight resistance, retiring in the direction of Port Arthur after firing a few shots.

The advance was resumed on the 18th. The country is very mountainous and the roads execrable, presenting great difficulties to the artillery and supply columns. Five miles from Kinchow, at the neck of the peninsula, the space between the Yellow Sea and the Gulf of Pechili is not a mile and a half wide, one road only runs across it, and a few resolute men could have turned it into a veritable Pass of Thermopylae. This narrow neck once passed, two roads lead to Port Arthur. One, following the shores of the Yellow Sea, reaches the city on the east; the other, running southward along the Gulf of Pechili, enters the city on the north; the bulk of the army marched over the latter. A mixed detachment of one regiment of infantry, a detachment of cavalry and engineers, etc., took the southern road. During November 19 the Japanese covered 25 miles of this exceedingly difficult country, up and down mountains, with a faith in Marshal Saxe's maxim that "victory resides in the legs of the soldiers," the advance guard arriving within 4 miles of the enemy at 8 p. m.

Port Arthur itself lies around a large inlet. From seaward the port is entered by a narrow channel diminishing to less than 300 yards across within the three-fathom line. This channel runs northward from the open sea for a little less than three-quarters of a mile, for two-thirds of which it is enfiladed by a fort placed

on a curving spit on the western shore, known as the Tiger's Tail; while another fort on the opposite bank commands nearly the whole passage. The distance of the first-mentioned fort from the entrance is about 900 yards, the second about 600 yards. The bay outside is also dominated by numerous batteries, which cover a front of nearly 4 miles. These works, twelve in number, were nearly evenly divided between the eastern and western sides of the entrance to the harbor. They were armed with about 50 Krupp guns, varying in calibre from 6 to 9½ inches, together with several rifled mortars and rapid-fire guns. The entrance to the port, which was commanded by a hill on either side, from 400 to 450 feet high, was also provided with an elaborate submarine mine defense, supplemented by booms and a flotilla of torpedo-boats. Once the strait was passed, the basin opened out on the eastern side, while on the west the land-locked bay widened suddenly behind the Tiger's Tail into a broad shallow lake. Nature herself had protected this stronghold from a land attack by surrounding it with a semicircular chain of hills from 300 to 600 feet high, both extremities resting upon the Yellow Sea. These hills were crowned with forts connected by miniature Chinese walls, redoubts, and shelter trenches. Across a valley a mile wide, and facing these hills, was another chain of hills which the Japanese seized, the Chinese having failed to occupy them, and established their advanced posts upon the most commanding of them, whence they obtained a good view of the entire Chinese defenses.

On the morning of November 20, the advance guard being the only Japanese troops in position, and most of the artillery some distance away, the Chinese appeared in a new role and began what the Japanese supposed was a very opportune attack, which, had it been executed with any vigor, would most likely have proved disastrous to the latter. As usual, however, it degenerated into a weak demonstration, demoralizing to the troops making it, and encouraging those against whom it was directed. Several shots were fired from the works opposite the hills occupied by the Japanese advanced posts, the shots being directed at the staff officers engaged in studying the ground, after which a column of about 2500 men was seen emerging from the center of the chain of hills constituting the first line of defense. Suddenly a second column appeared advancing towards the Japa-

nese right, and then a third column upon their left. These two columns were each about 2000 strong, and after occupying some hills within range on the flanks of the Japanese positions, waited for the central column, which advanced in fine order about 2 p. m. Two mountain batteries and some infantry from the Japanese main body were brought up in great haste, the guns being posted in good positions on the hills previously selected by the staff. The infantry were partly massed in rear of the front hills and partly extended as skirmishers in front of the guns and between the hills. When the central column was about 1500 yards distant the right mountain guns opened fire, the shells falling in the midst of the leading troops. The column halted for a moment, but a few more shells bursting in the thick of them caused them to turn tail and make for Port Arthur in the wildest disorder. The fire of the guns still pursued them, dropping shrapnel with unerring aim over their heads, completely demoralizing them. While this was going on the right and left columns were simple spectators, fearing to approach any nearer. As soon as the central column had fled beyond range, the Japanese guns paid their respects to the column on their right with the same result, a few shells bursting in their ranks producing a stampede. The right column looked on for a while, but without waiting to be served, turned about and made for their works. All this while the forts were concentrating their fire upon the two batteries, but without effect, their range being too great. By 5 p. m. the last Chinaman had retired without firing a shot.

The remaining artillery as well as the rear guard having arrived, the siege guns were mounted during the night within a mile of the Chinese works. The infantry began the advance at 2 a. m., and under cover of darkness were disposed for the attack. The artillery was posted in the center of the line, commanding the right, left, and center of the Chinese position. The cavalry covered the right flank to prevent the enemy's escape to the westward. The army was divided into a right and a left wing, composed respectively of the first and second divisions, each division being composed of two brigades, with only one battery posted in rear of the center as a reserve. The right wing was to take the three forts opposite them, after which the second division was to attack the enemy's left and the forts in their front.

About 6 a. m. one of the siege mortars opened the fight, and in

an instant all the mortars, field and mountain guns, over 40 in all, were pouring shell into the Chinese forts. The Chinese replied promptly with the 12 heavy guns in the three forts on their left, but their practice was bad. The largest of the Chinese sea forts also turned its guns upon the mortars, but without effect, their elevation being too great. The Japanese siege mortars produced little result, their projectiles nearly all falling short, but the field and mountain batteries were served with deadly effect after they had changed their projectiles from shell to shrapnel, having observed that the former had little or no effect upon the walls of the forts, while the latter burst with the utmost precision behind the parapets, spreading death and destruction within the works. The artillery duel lasted about an hour, toward the end of which the fire from the forts became weak and irregular.

As the Japanese guns ceased their fire, the first brigade on the right of the line was led by its chief against the most westerly (or left) of the three forts. Soon after beginning the advance they encountered 1000 Chinese who had sallied from the forts, but a few volleys soon dispersed them. The fort now brought 4 big guns to bear upon these troops, but they advanced steadily under a hail of shell from these guns, supplemented by the fire of a body of infantry behind the parapet. Reaching the foot of the hill, 400 feet below the fort, the brigade halted for a moment to pull itself together, the broken ground now protecting it from the hostile fire. Only a moment, out it came, steadily it advanced up the mountain over this shot-swept zone, without wavering, as if on parade. By 8 o'clock the leading troops were under the parapet, and with a cheer the assault was made and the defenders turned out. The guns of this fort were at once turned upon the two others, but their garrisons seeing the fate of the first fort abandoned them and ran toward the town.

The Japanese left wing was really little more than a mixed brigade, and while it had for its task the capture of the strongest part of the Chinese defenses, consisting of eight forts, upon hills from 400 to 500 feet high, it was not to attack until the works on the Chinese left had been captured, thus taking into account the depressing effect upon their defenders, whilst increasing the ardor of the attackers and inspiring them to greater efforts. This attack upon the enemy's right was to be supported by the heaviest artillery, including 4 long-range guns of 12 centimeters, and

was commanded by one of Japan's most promising generals, Kasegawa. The artillery was to reduce the works, when the infantry would make the assault. The execution of this plan however was not equal to its conception. As we have already seen, the transport carrying the ammunition and horses of the siege mortars was destroyed just as it was about to unload. The mortars had therefore hardly any ammunition, and the troops being somewhat new to them did not serve them with such good effect. During the attack of the first division 3 of the long-range guns arrived, but the difficulty of bringing them up to the elevated position selected for them and mounting them was so great that by the time the first gun was fired the infantry had advanced so far to the front as to mask them, and they were of no further use; the consequence was that this single brigade of infantry was confronted with the task of taking these seemingly impregnable forts. It was a little before 9 o'clock that the infantry, which until then had remained hidden, approached in its advance across the valley separating the two chains of hills. During the advance the field artillery, which had been preparing the attack of the right wing, quickly changed from its first position on the left to about a mile from the first of the line of eight forts, and began shelling it. The fort replied briskly, but in a few moments huge clouds of smoke were seen, followed by a terrific explosion. The magazine had gone up and the fort was on fire. As the small shells the Japanese were using were unlikely to cause a conflagration, it is probable that the explosion was caused by the Chinese. The defenders served their guns well, concentrating the fire from the eight works upon the attackers with good effect. Several shells landed in their ranks, raising clouds of dust, earth and stones, but upon clearing, the steady columns could be seen, well closed, marching bravely forward.

At this time the detachment on the southern road along the Yellow Sea appeared on the left, advancing to the attack over a flat unprotected road under the fire of four of the forts, which was now turned upon them. This fire became hotter as the troops approached nearer; the quick-firing guns, revolving cannon and thousands of small arms joined the big guns in their effort to repel the attack. Had the practice with these weapons been at all skillful the brigade would have been completely wiped out; as it was, their advance was so precise and steady as to call forth

exclamations of surprise from the foreign attachés who witnessed it. Reaching the foot of the hills across the valley, the trumpets sounded the charge, and up the hill they swept to the assault; suddenly an enormous cloud of smoke was observed and a great explosion was heard, followed by three others; the Chinese had sprung their mines charged with dynamite which had been laid half-way up the hill. Their excitement and anxiety had caused these deadly auxiliaries to be perfectly ineffective, as they were sprung too soon, and not a man was injured. When the smoke disappeared the attackers were seen under the parapets of three of the forts, not in the least affected by what might have proved demoralizing to the best disciplined troops of any western nation. The infantry entered the works a moment later. The column on the extreme left had also captured the fourth fort, and the advance was promptly resumed against the remaining works, which were quickly abandoned.

It was not quite noon when a great cheer rent the air, announcing the capture of the eleven land forts. The commander-in-chief received the reports of his generals, and at once gave the order for the first division to take the town. The road into the town passed between two hills, the one on the right having a battery of 3 guns on it, served by the best gunners the second army had yet been opposed to. On either side of the road were shelter trenches, the troops being armed with repeating rifles. Although the Japanese made the most intelligent use of the ground it was found impracticable to advance under such a galling fire as they received, and it was not until a small detachment crept around on the flank of the trenches, enfilading them and causing their defenders to retire, that the leading troops crossed the bridge and entered the town, about 2 p. m. Attention was then turned to the only fort not in possession of the Japanese. This was the largest sea fort, which, however, was found deserted, its garrison having escaped. It was just 4 o'clock when the Japanese colors floated over this work, and the chief of staff, saluting the commander-in-chief, modestly said: "Field Marshal, I believe Port Arthur is now in the hands of our soldiers."

Thus fell to the Japanese the finest and most perfectly equipped naval arsenal the Chinese possessed. It contained a dry dock 400 feet long—the only one in China capable of receiving their

largest vessels,—its numerous workshops were fitted with the most approved plants for the construction and repairing of vessels, the shops and storehouses being connected with the tidal basin by a railway. There were several fine steam cranes for facilitating loading or unloading war material, for the manufacture of which the foundries and other departments were perfectly equipped, even to the torpedo shops, where these weapons were tested and repaired. In the harbor were two small steamers, a fine sailing ship, an expensive dredger, a partially completed gunboat, several hundred tons of steel rails and 450 fish torpedoes. To these must be added about 100 Krupp guns, thousands of small arms and tons of ammunition, and we have some idea of the value of this victory.

A notable feature of the battle of Port Arthur was the employment for the first time of a new weapon designed for use against fortified positions. After the investment of Paris in 1870-71, Germany and other European nations, as the result of observations upon the extent of injury caused to fortified positions by gunfire, went into the matter of providing batteries of light and short howitzers for moving swiftly upon intrenched positions and works, and crushing them by weight of metal and high angle fire. Krupp of Essen succeeded in producing the piece used by the Japanese, which has already been referred to as a siege mortar. This short howitzer, or mortar, although only of 4¾ inches caliber, throws a shell of 80 pounds. The projectile is said to be so long that it protrudes from the muzzle when the piece is loaded. This piece was employed as a general thing in lieu of the regular siege train by the Japanese. We have seen that the best possible results were not obtained from the weapon, owing to a scarcity of ammunition and its novelty in the hands of the troops, who failed to serve it with the efficiency so characteristic of them. It goes to show, however, that the Japanese were possessed of the latest and most improved implements known to their trade.

Port Arthur shows that the second Japanese army was not inferior to the first in its knowledge of the military art. Witness the promptitude with which the staff recognized the fatal error of the Chinese in violating one of the first principles of field fortification, which is, that no work should be commanded by any ground within the range of any weapon likely

to be brought against it. The chain of hills facing those upon which were situated the works constituting the Chinese first or outer line of defense dominated the Chinese position, and it was from the tops of them that the Japanese staff carefully studied the defenses, devoting so much time to this operation, and being so near—the valley separating the two lines of hills being but a mile wide—as to become a target for the guns of several of the forts. The staff were quick to recognize the value of these hills, seizing them at once with their advanced troops, and establishing their batteries by night in such positions as to command the entire line of the defensive works. It may be noticed that their tactics in bringing up their infantry to the positions for attack under cover of darkness proved as successful as in previous actions.

We observe that the left wing of the Japanese army, only a little more than half the strength of the right wing, was detailed for the attack of by far the stronger portion of the defenses in the plan of battle; but we must also note that the attack by this column was not to begin until after the works on the Chinese left had fallen. By this disposition the commander-in-chief developed the maximum power of his army. Confident of the ability of the first division to capture the three forts they were to attack, he no doubt believed in Napoleon's dictum that "in war the moral effect is to the material effect as 3 is to 1," and relied upon the demoralizing effect upon the Chinese of seeing their defenses in the hands of the enemy, as well as the incentive this would prove to more heroic exertion on the part of his own troops. Besides, it is a mistake to attack a fortified position with equal strength at all points.

Here we have again the influence of the telegraph upon strategy. By means of the telegraph the position of the detachment advancing over the southern road, which we have seen arrive upon the field with clock-like punctuality joining in the attack, was known at all times.

Port Arthur proves how fully the Japanese recognize the importance of the terrain in military operations. When they halted at the foot of the hills, covering themselves from fire whilst they reformed for the assault, or when the ground was unfavorable for such tactics, as was the case with the detachment from the second division, their adroitness in passing over

the shot-swept zone, the troops of the various units throwing themselves flat upon the ground and covering each other by their fire during the forward rushes, they showed themselves to be adepts in the application of modern tactics.

This brilliant feat of arms had but one defect to mar its perfection,—that was the lack of ammunition for the siege howitzers, which in the plans had been relied upon for breaching purposes. This was caused by the burning of the transport already mentioned, but its effect was largely counteracted by the deadly precision with which the shrapnel from the field and mountain guns burst behind the ramparts, the gunners being quick to notice that it was useless to attempt to breach the walls of the forts with these guns, and promptly changing their projectiles from common shell to shrapnel. We must not forget the clever turning movement of the small column which crept around upon the flank of the shelter trenches and battery commanding the flat road into Port Arthur, enfilading them and causing their defenders to retire, carrying out the German creed: "The front is difficult—let us try the flanks."

The errors of the Chinese are only too apparent. First, the narrow neck near Kinchow should have been fortified and tenaciously held. Indeed the ground for several miles in advance of the neck was most admirably adapted to the defense. Second, the outer line of the land defenses should have been established upon the hills the Japanese occupied, and they should have constituted the principal defense, since they commanded all the ground within cannon range, both in front and rear. This position might have been turned into a sort of Chinese lines of Torres Vedras. Had the Chinese been as well versed in outpost duties as their adversaries, they would have realized that the Japanese advance guard, tired and worn out after its march of 25 miles during the 19th of November, might have fallen a prey to an earnest attack during the night, unsupported as it was; or, if the attack on the Japanese on the 20th had been carried through to an assault, it is possible that it might have succeeded. At least they had troops ample to have attacked successfully, as only a portion of the Japanese main body had arrived and a large part of the artillery was not up, while the rear guard was a long distance off. The land forts on the right of the line could have assisted in repelling the attack of the Japanese right wing, whereas

they did not fire a shot until they themselves were attacked. There were six general officers exercising equality of command, with results to be expected. In short, we see here, as elsewhere, ignorance, discord, lack of coöperation, and frequently arrant cowardice. Nothing else could account for the capture of this Gibraltar of the East, with losses which were nothing to what they ought to have been. The forces engaged in this battle were reported as about 20,000 for the Chinese, and from 15,000 to 18,000 for the Japanese.

It is impossible to find a parallel to Port Arthur in the perfection of the combined tactics of the land and sea forces. While the water defenses appear to have been sufficient to deny entrance to the Japanese fleet, the vessels were handled in the most skillful and efficient manner outside of the harbor, drawing the harmless fire of the forts, causing them to expend their ammunition whilst husbanding their own. They nevertheless supported the troops in the most superb manner, coöperating with them in a way probably never seen before. Marshal Oyama, from his headquarters on shore, out of sight of the fleet, kept the vice admiral informed of his progress during the action, directing his movements from time to time as the coöperation of the fleet appeared desirable, indicating the successive targets for the guns of the fleet, into which they dropped their shells in conjunction with the field batteries.* While the whole world wondered at the efficiency and versatility of our navy during the civil war as shown by its coöperation with the land forces in the rivers and upon the coast, from which the most valuable lessons known to naval warfare of this description were drawn, we had nothing quite like this almost automatic precision of Port Arthur. Now how were these great forces of the two elements directed by one controlling mind? By that novel and valuable appliance in war which had contributed so largely to their previous successes—the field telegraph. The line from the marshal's headquarters was connected with a signal station within sight of the vessels of

* A British officer who witnessed this fight from the deck of the Porpoise says: "On a signal from the general on shore, Admiral Ito's cruisers all steamed past the forts just out of range, without replying, only drawing the fire off the torpedo-boats, which did all the work. The torpedo-boats were dashing about in all directions, but were obeying the signals of the convoying cruisers, which again followed the orders conveyed by Field Marshal Oyama's field telegraph."

the fleet, by which means perfect communication was maintained between the two during the fight. In this respect Port Arthur is without a parallel, and alone should be sufficient to convince us of the intelligence and efficiency of these sturdy little fighters in their first war under modern conditions. In addition to this perfection of mechanical conditions, there existed an accord, a singleness of purpose, between the two commanders which it is impossible to surpass, and which perhaps, as much as any other factor, produced this extraordinary action.

Oyama after providing a garrison for Port Arthur detached a division which advanced up the peninsula, with Niuchwang as its objective. This division drove the Chinese northward towards Niuchwang, capturing Foochow and Kaiping. At the latter place some 4000 Chinese were found strongly intrenched, requiring something of an effort on the part of the invaders to dislodge them. An attack was first made upon the two wings, then upon the center, and finally, by a flank movement enveloping the position, the Chinese were routed.

As we have already seen, a junction was now formed with the first army, which occupied Haicheng and the vicinity.

From January 17 to March 4 the Japanese divisions were intrenched in positions from Kaiping to beyond Haicheng, their forward movements suspended on account of the severity of the weather and the difficulty of operations. During this period the Chinese took the offensive, advancing from the direction of Liao Yang in strong force upon Haicheng in two separate attacks, which really were little more than weak demonstrations, and it was only by a *ruse de guerre* that the Japanese commander-in-chief, who was present, succeeded in bringing his enemy under fire. In the second attack, which was a night affair, and which from information furnished by his covering detachments he expected and was prepared for, his dispositions were made in such a manner as to draw the Chinese within 700 yards of his line, when falling upon both flanks, he threw them into confusion, amounting to panic, during which many prisoners were captured. During the same period four or five similar attacks were directed against the Japanese at Kaiping from the direction of Niuchwang and Yinkow, the port of Niuchwang.

The Japanese now resumed their advance upon Niuchwang.

On February 28 the force at Haicheng routed 15,000 Chinese encamped between the roads to Liao Yang and Niuchwang, thus clearing their flank and rear of the enemy; and four days later two actions came off. The force from Kaiping captured all the defenses of Yinkow, on the south and west, on the left bank of the river; and two divisions from Haicheng attacked Niuchwang itself, where the Chinese did some excellent street fighting, only yielding street by street, keeping up the contest from 10 a. m. till 11 p. m., and leaving 1880 of their own and 200 of their enemy's killed and wounded as evidence of the stubbornness of their defense. The advance was continued, after this victory, against a large body of Chinese strongly posted at Yenchaitai on the west bank of the Liao Ho—which was still frozen over—15 miles west of Niuchwang.

On March 6 the dispositions were made for a combined attack in three columns, from the east, northeast and northwest. At 7 a. m. the bombardment commenced, and was continued until 10.30 o'clock, at which time, under cover of the artillery, three columns stormed the position. The defenders at first fought stubbornly, but being outnumbered eventually broke and fled with a loss of 2000 men. The town was set on fire by the Japanese shells, and by night was burned to the ground. With this action the operations in Manchuria were brought to a close, the armistice preceding the declaration of peace following closely upon it.

In reviewing the actions of the first and second armies, which bore the brunt of the fighting during this war, one is struck with the consistency with which the Japanese applied one of the most important elements of modern tactics, that is, a proper preparation by artillery fire of the point of attack before the assault is made. We find no disregard of this necessary precaution such as we remark in the Franco-German war of 1870, as evidenced by the admonitory order of the King of Prussia upon that subject, nor such as was so frequently exhibited by the Russians in 1871, particularly in the earlier battles of Plevna, which their unnecessarily great losses attested. On the contrary, we note the most intelligent coöperation of the two arms, each in its proper sphere.

Of the stuff of which the Japanese infantry and gunners were made we may form some opinion from the foregoing narrative.

As to the cavalry it is hardly necessary to say that the theaters of operations were not adapted to the employment of that arm to any great extent. They were most efficient and valuable however in outpost and patrol duty, acquiring a reputation in this direction hardly second to that of the sister arms. That there was no Japanese Bredow was solely from lack of opportunity. One incident which occurred on the march down the peninsula to Port Arthur may help to convince us of this. On November 18 a body of Japanese cavalry of inconsiderable size, forming the leading detachment of an advance guard, came in contact with a mixed detachment of Chinese infantry and cavalry 3000 strong. The Japanese charged, became surrounded, were rescued by a company of infantry from the advance guard, who in turn were hemmed in. The cavalry charged repeatedly and furiously through the Chinese cavalry, releasing the infantry and covering their retreat,—not quite up to Bredow's work at Mars-la-Tour, but very good for the hardy little ponies many of us are familiar with. As may be imagined, this cavalry was lightly mounted, but equipped in the most approved style, even to French jackboots, their arms being the saber and short carbine.

Operations of the Third Japanese Army.

The third Japanese army, having for its objective Weihaiwei, the second Chinese arsenal, at the entrance to the Gulf of Pechili, was composed of the Sendai division, which sailed from Hiroshima early in January for Talien Bay, the point of rendezvous, and the Kumomoto division, which formed part of the second army at the capture of Port Arthur. This force of about 25,000, with 12 field guns, 36 light mountain guns and 12 mortars, sailed from Talien Wan in two detachments, the first on January 19, reaching Yung Ching at daybreak the following day. Immediately upon arrival, a force of marines in boats from the fleet landed in the face of a feeble fire from an earthen battery of 4 guns, whose defenders were dispersed by the fire from the guns in the boats, and the marines advancing in a deep and heavy snow completed the rout. The beach having been cleared, the landing of the troops began, and by night the advance guard had captured the works at Yung Ching by assault and the main body was on the march thither. On the following morning the

second detachment arrived and completed its landing during the day. About this time a small force was landed from the vessels of the fleet under cover of their guns at Teng Chow, west of Weihaiwei, as a diversion, but this force was withdrawn a little later.

From Yung Ching the country breaks from a gently rising plain into a succession of hills and valleys, the declivities unusually sharp and steep. Deep snow covers the ground from December to the end of February. Five ranges of rocky hills running from 1000 to 2000 feet high intersected the line of march. The difficulty of transporting an army over 30 miles of such country, carrying every pound of fire-wood and food, besides ammunition and stores, will be readily recognized. The two divisions advanced over two separate roads, the Sendai division by the inner road, and having with it all the field guns, it being impossible to transport any vehicles whatever by the track nearer the coast, over which the Kumomoto division advanced. When we remember that the thermometer during this march stood at 12 degrees Fahrenheit, we may compare it with operations in the Crimea, not forgetting that here a high, seemingly impracticable mountain is thrown in every now and then, that no railroads exist, that mere footpaths are substitutes for roads, and that food is terribly scarce at all times.

Weihaiwei is by nature perfectly fitted to protect a fleet. It is landlocked on three sides, and three large islands heavily fortified guard its mouth. The hills on the three landward sides range from 1200 to 2000 feet in height, and the eastern arm was protected by five first-class forts constructed by German experts at great cost and armed with Krupp guns. In the harbor at the time of the attack were 6 ironclads, 8 gunboats and 12 torpedo-boats. Mine fields were laid between the island of Liu Kung and the eastern and western arms of the mainland. A line of booms was also placed just inside the mine fields. The town lying on the west side of the harbor, enclosed by hills on three sides, was surrounded by a wall 25 feet high and 40 feet thick at the base. This wall was rectangular in shape and pierced by four gates at the four chief points of the compass. The naval workshops were situated on Liu Kung Tao, upon the summit of which was a signal station 510 feet above the sea, commanding an extensive view of the land and sea approaches. Across a valley on the highroad to Chefoo a line of intrench-

ments had been thrown up. On the top of the hill to the right, a difficult height to climb, 3 field guns had been mounted. The strength of the garrison of the eastern forts was 3000 men, while the same number defended the western and northwestern forts, and 1500 men were in the forts on the islands. The whole of these defenses were under the command of Admiral Ting.

As already stated, the Japanese army advanced in two columns, the Sendai or second division taking the inner route, of a somewhat circuitous nature, in order to attack the western forts, and the Kumomoto or sixth division following a path near the coast against the eastern forts. The sixth division arrived in front of the eastern forts on January 30, and by night had occupied all of them, the Chinese making no defense worthy the name. Fifty gunners were landed from the fleet and the guns turned upon the Chinese fleet.

The task of the second division was a little more difficult. Owing to its longer and more difficult march it did not arrive before the western forts until three days after the eastern ones had fallen and their garrisons had fled to the western,—at least those who did not continue on to Chefoo. The division was divided into two wings, the right advancing from the southwest, the left more to the northward advancing over the Chefoo road. The right wing encountered little opposition and found the southern forts of the western series deserted. The left wing, on the contrary, encountered 2500 Chinese with 4 guns well posted in the mountains about 12 miles west of the town, and an action came off lasting from 11 a. m. till 2 p. m. in the midst of a blinding snow storm, accompanied by a fierce wind blowing the frozen particles in the face, rendering it almost impossible to see any distance. After an effective use of shrapnel the charge was ordered, resulting as usual in the retreat of the Chinese, part by a path towards Chefoo, the remainder scattering in the mountains. The road to Chefoo was now clear of Chinese and the telegraph between that place and Weihaiwei cut. All the forts to the north and west were now occupied without further resistance, as their garrisons abandoned them at the first approach of the Japanese, and Admiral Ting had sent men from his fleet to demolish the works and disable the guns. The Japanese, however, established their field guns and mortars in these works, or rather above them, and plied the decks of the

Chinese vessels in the harbor so effectively as to keep the men under cover continually. Fighting between the mainland forts and the Japanese fleet on one side, and the remaining Chinese vessels and forts on the islands on the other, continued until the morning of February 12, when terms of capitulation were arranged; and on the 17th the Japanese entered the harbor, taking possession of the forts on the islands, the torpedo stations, workshops, and 2 ironclads, 1 cruiser, and 6 gunboats, with an aggregate tonnage of 12,660. Thus disappeared the last vestige of Chinese power upon the sea.

Here, for the first time, we observe a want of that perfect punctuality which existed in all other concentrations upon the field of battle, and a consequent want of the usual simultaneity in their combined attack. We may account for this in two ways: first, communication between the two columns and headquarters was probably not maintained, through the impossibility of using the field telegraph on account of the difficult country through which the advance was made; second, being stronger in numbers, immeasurably so in *morale*, his troops fresh from the field of a great victory, eager to meet an enemy fighting almost in his last ditch, the Japanese commander did not feel it necessary to hold his right column until his left came up; and we cannot, therefore, accuse him of assuming any undue risk.

While the fleet coöperated in the heartiest way here as at Port Arthur, performing its part in the most skillful and efficient manner, its task was of a secondary nature—mainly to draw the fire while out of range and to watch the entrance to the port. Both Port Arthur and Weihaiwei were essentially land victories, and this fact alone shows the victors to have been cognizant of the modern conviction, arrived at after a study of the operations before Charleston, Vicksburg, Fort Fisher, and Alexandria—that the fire of a ship is altogether unable to breach or seriously damage a properly constructed parapet—while such unarmored vessels as composed for the most part their fleet would have been riddled, if not destroyed, in such an unequal contest. We see them wisely, therefore, refraining from futile attacks from the sea, except in support of the principal attack on land, which would result in a useless expenditure of energy and ammunition.

In the defenses from seaward in both of these Chinese maritime fortresses we find the moral effect of submarine mines

confirming the lessons of the Franco-Prussian war, where these most effective auxiliaries paralyzed the offensive power of the French navy, its greatest effort proving abortive through dread of them. Submarine mines supplemented by booms in rear of the mine fields proved wholly sufficient to keep the Japanese vessels out of the harbor.

Port Arthur and Weihaiwei have frequently been referred to as commanding the entrance to the Gulf of Pechili, and their tactical value greatly overrated. Such a strong analogy exists between the importance and functions of a strongly fortified naval base and a land fortress or intrenched camp, that an exposition of the place of the latter in military warfare may enable us to place a proper value upon the former.

Napoleon says of fortresses: "It is true they will not in themselves arrest an army, but they are an excellent means of retarding, embarrassing and annoying a victorious enemy." According to Prussian theories, fortified places should fulfill certain strategic conditions. They should protect important cities, supply-depots, or depots for troops; should defend communicating roads or important passes; should serve as points of support or pivots for either defensive or offensive operations, and as a refuge from pursuit. Fortresses near the flanks of lines of operations have frequently been found, if not of the first importance, yet of such value as to prevent their being ignored by a commander who sought for success in his operations, for from them expeditions may be made upon the lines of communications of an army, and its flanks may be so constantly menaced as to endanger its advance. It has been a common mistake, however, to treat such works with more respect than they deserve, and to besiege, invest and blockade them. Jomini says: "Formerly the operations of war were directed against towns, camps and positions; recently they have been directed only against organized armies, leaving out of consideration all natural or artificial obstacles"; also: "An invading army may pass by fortified places without attacking them, but it must leave a force to invest them or at least to watch them." Thus Wellington and Blücher in their advance on Paris after Waterloo detached small bodies to mask the frontier forts, while the allies of 1793 delayed their advance across the frontier until they had captured the fortresses upon it, the delay enabling the republican armies to rally and reorganize for the defense and

eventually to assume the offensive and to commence that career of victory which continued with few intermissions for eighteen years. Jomini says: "Some have attempted to draw a parallel between the efforts of 1793 and 1815. . . . But the allies of 1815 acted very differently from those of the first invasion; they did not, like Mack and Coburg, pass three months before Valenciennes; the times had in all respects changed."

"An excessive tendency to the employment of fortifications has its origin in a feeling of moral weakness. Fortresses are of service only in a war against a superior enemy. But the weaker may be morally strong, and in this case only will it make a judicious use of fortifications. They are, on the contrary, dangerous for the side which is morally weak. For such a nation they have an irresistible attraction. Persuade a people that the center of gravity of the country's defense is to be found behind the ramparts of its fortresses, and long before the necessity arises you will see the army recruited from this people fleeing to these defenses, and if there is not found behind these walls the anticipated security, the fate of that country will soon be decided" (Blume's Strategy). A French writer as early as 1628 says of them: "The strongest of them do not hold out six weeks; the best cannot take care of themselves without an army close at hand"; and Napoleon says: "It is upon the open field of battle that the fate of fortresses and empires is decided."

According to recent French writers, it may be admitted to-day that a fortress ought never to be considered as a base of operations for an army; that is to say, it is insufficient to furnish the army definitively with a refuge in case of defeat or a pivot for its offensive operations. That it should temporarily serve the army for shelter, that it should be a *point d'appui* in strategic manœuvers, that it should cover concentration or a movement by controlling the means of communication of which an enemy must make use to harass these different movements,—all this is indisputable. But in no case ought an army to shut itself up in a place, or even to take refuge there sufficiently long for an enemy to be able to complete the investment thereof.

What other deductions is it possible to draw from modern history with such examples as Metz, Vicksburg, and Plevna? In the first place, the security which Bazaine supposed would be his salvation proved his ruin. Instead of fighting his way through

to Chalons, where McMahon was covering Paris, as he had reported he would do, he allowed himself, at the head of about 125,000 men and 390 guns, to be driven off the Verdun road and sealed up in Metz by 72,000 men with 246 guns. It would seem from the German official report of this war that they expected exactly what happened, and in discussing the possibility of breaking the lines of investment, would say: "But Marshal Bazaine might hope in all cases to find his line of march open, to sever temporarily the but weakly guarded communications of the Germans, and although not without considerable difficulties as to supply, to escape with a large part of his army to the southward." When he did make his sortie he had given the Germans time to strengthen their lines sufficiently to repulse his attack, although conducted with skill and vigor by General Le Boeuf with his own corps.

Great armies which are shut up in a fortress after lost battles are, as the history of investments from Alesia down to Metz proves, always lost. Among all relations between fortress and field army, the latter must make it a supreme rule never to allow itself to be thrown into a fortress. It is always better to use it as a support, which enables the field army to keep its full freedom of action. An army can easily be got behind fortifications, but only with difficulty back again into the open field, except it be that strong help from without lends it a hand. Fortresses protect the troops they contain, but at the same time anchor them to the spot.

Vicksburg was very similar to Metz. In reply to an order from General Johnston to move out and attack the enemy near Clinton, General Pemberton, then behind the Big Black, near Vicksburg, overrating the value of that place, which had been passed by Porter's squadron, said: "My own views were expressed as unfavorable to any movement which would remove me from my base, which was, and is, Vicksburg." Upon receipt of this, Johnston's instructions to Pemberton state: "If you are invested in Vicksburg you must ultimately surrender. Under such circumstances, instead of losing both troops and place, we must, if possible, save the troops. If it is not too late, evacuate Vicksburg and its dependencies and march to the northeast." This order was not obeyed. According to General Grant's report, the investment of Vicksburg was completed May 19, and by July 4 it had surrendered.

Plevna, the last of these three famous intrenched camps, will ever stand as one of the most brilliant military operations of history, completely arresting the Russian advance and paralyzing the whole empire for five months, straining the resources of a mighty nation, yielding only to a siege and costing the besiegers 40,000 men. Yet its commander failed to comprehend its limitations, and by overstraining broke them, and thereby lost his whole army of 40,000 men. Like the commander at Metz, Osman Pasha made a brilliant effort to break through the lines of investment, but like the former commander, postponed it until it was too late to be effective. Indeed, General Todleben, the great Russian engineer, chief of staff of the besieging army, asked the Turkish chief why he did not retreat in October before the Russian reinforcements were all in position and the investment complete. His answer was that up to the day of his sortie he felt sure the Russians would continue their attacks, and he felt equally sure that he would be able to defeat them with great loss. He gave it as his opinion that the system of intrenched camps with modern breechloaders is admirable so long as the enemy has not troops enough to surround them. But it is their fate to be invested, and then they are doomed. Up to the time referred to, Plevna had brought the Russian operations to a standstill for three months, and had done all that could be expected from it. His failure to relinquish the security within its walls and save his army was the great defect of one of the most brilliant campaigns on record, which had placed the Turkish commander in the front rank of modern generals and gained for him the title of Conquering Osman.

All three of the commanders referred to failed of a just appreciation of the value of a fortified position in connection with an active army. General Brialmont, the great military engineer, says: "To know how to utilize the passive force of these positions for the profit of the active work of armies will always be the characteristic of great generals." It is quite clear then that fortified positions should be regarded solely as auxiliaries of the active force; that more than one good commander has been lured to destruction through the fatuous belief that in their protection lay his salvation. "Fortifications are good servants, bad masters."

After a few words upon Port Arthur and Weihaiwei from a purely military point of view, I shall endeavor to show how

applicable what has been said of fortified positions in connection with land operations is to maritime fortresses or strongly fortified naval bases in war upon the sea.

Port Arthur, as we have seen, lay on the flank of the communications of the Japanese army operating in Manchuria, and an active army basing itself upon that stronghold might have harassed the invading army—if it did not cause it to make a great detour to drive the defenders within their walls. An English writer says: "There is no doubt that this operation, taking up a flanking position, will be much oftener used in the war to come, on account of the sensitiveness of the modern army to its communications, and the fact that if you are invading my country . . . you dare not leave me with a field army on the flank of your communications without turning aside and thoroughly beating and dispersing me first." Substituting sealing up in the Liao Tung peninsula, by fortifying and holding with a small force the neck of land at Talien Wan, for beating and dispersing, we fulfill these requisites with regard to Port Arthur. As has been pointed out, the neck at the head of the Liao Tung peninsula, between Talien Wan and Kinchow, is the key of the position; and that this was recognized by the Japanese is shown by the tenacity with which they clung to it in connection with Port Arthur during the negotiations which followed the close of the war. Consenting to relinquish the conquered territory in Manchuria, they at first decided to fight before abandoning the peninsula from Talien Wan, realizing that by turning it into a vast intrenched camp capable of harboring an army of any dimensions, which upon short notice could be concentrated there, they commanded the situation in the East upon the land.

Command of the sea would have been necessary on the part of the Chinese for the employment of Port Arthur as a base of operations against the Japanese communications, as the Japanese army in Manchuria could have cut off all supplies from landward; and it would be equally indispensable to the Japanese in keeping their intrenched camp referred to above supplied.

After the invaders had advanced well into Manchuria, assuming their objective to be Peking by way of Moukden or Niuchwang, Weihaiwei might have harbored an army which would have proved a constant menace to the base of an army operating against Peking from the southern shores of the Gulf of Pechili, in conjunction with a force in Manchuria.

It was not on account of their offensive qualities that the Japanese deemed the reduction of these fortresses necessary. Admiral Colomb says in his "Naval warfare": "In all attacks made over sea against territory, we shall note one almost universal rule—no attacks of magnitude are ever known direct from a distant base." It is clear that with Peking as the objective, a base upon the Gulf of Pechili would sooner or later become necessary. While we have seen an army operating northward after the capture of Port Arthur, we notice its base was Talien Wan, at which point the third army was also concentrated, and from which it embarked. The natural base of operations against Peking is on the shores of the Gulf of Pechili, at the mouth of the Peiho, or at Shanhaikwan, whence there is a railroad to Tientsin. The possession of Port Arthur and Weihaiwei by the Japanese meant the command of the sea, with the ability to select this base. Supposing the strategy of Japan to have contemplated a simultaneous movement upon Peking by three armies advancing from Wiju, Port Arthur, and Weihaiwei as primary bases, around the Gulf of Liao Tung and Liao Chow Bay,—and their movements up to the moment of the cessation of hostilities make this appear quite possible,—successive bases would have been taken up along the shores of those waters as the troops advanced, in order to shorten their lines of communication.

While the fortresses lay on the flanks of the communications with the home bases, they were of themselves tactically a negligible quantity; their guns were harmless. Their great value was as adjuncts of an active fleet. As harbors of refuge for the Chinese fleet operating against the lines of communication of the enemy, they were of inestimable value. Here was a field pregnant with possibilities. To swoop down upon some belated cruiser or luckless transport with a superior force, to send out among the islands numbers of torpedo-boats to operate in the channels under cover of darkness, harassing and retarding the operations of the enemy,—herein lay the value of the strongholds. It would have been foolhardy for the Japanese to have attempted operations along the shores of the Gulf of Pechili with these fortresses upon their flanks and rear harboring a fleet. Admiral Colomb is authority for the statement that "no fleet can be secure against interruption in any operation, such as the transport or landing of troops, or a terri-

torial attack, so long as possibly interfering naval forces of the enemy are unmasked or free to act against it."* But the fortresses were merely auxiliaries of the fleet, to be relinquished upon the first appearance of the danger of being masked or sealed up. The Chinese commander, however, like those of the armies of Vicksburg, Metz, and Plevna, courted destruction by clinging to his base until it was too late to escape. The instant the blockade from seaward was completed the fate of the fleet was sealed. Suppose it did require the entire Japanese fleet to mask it, the sea was left open to the undisturbed movements of their transports, and their supplies assured. While I do not intend to discuss the naval operations of this war, I cannot refrain from calling attention to the possible result of the abandonment of its base by the Chinese fleet, forming a junction with the southern squadron, and becoming that "possibly interfering naval force" referred to by Admiral Colomb.

To the Japanese fleet, Port Arthur was a pearl without price, with its perfect facilities for docking, repairing and refitting, saving a journey of 1400 miles to the home dockyards, with the attendant danger of destruction or capture to the detached vessel. The importance of its possession, or of its counterpart across the water, needs no argument—a glance at the map is sufficient. Indeed it is difficult to find a war in which the command of the sea was fraught with graver consequences. Japan's insular position, her great distance from the theater of operations, with the

*In this connection Captain Mahan is quoted as saying, referring to the Chinese convoying fleet and the action at the mouth of the Yalu: "The prominent lesson of the engagement was that it is necessary that the fleet convoying transports should be decidedly superior to the enemy. . . . The whole affair illustrates the extreme difficulty of the attacking movement across the water, unless the attacking force had the control of the water absolutely, . . . The question was in this case whether it was worth while to take such risk for the sake of landing troops." Referring to the Chinese attempt to carry a force across the water, Captain Mahan pointed out that the incident showed that the mere existence of a hostile fleet did not constitute a deterrent force upon the movements of a resolute man. The fleet "in being" was doubtless a most important factor to be considered in making such an attempt, but it was plain that that fleet would not deter a man who saw that the object of his attempt was sufficiently important to justify the risk taken. What remains to be seen is whether the object accomplished was such as to justify the risk.—(Remarks of Captain Mahan published in the Army and Navy Gazette, London, after the battle of the Yalu.)

resulting long lines of communication, all made it peculiarly desirable to her. Without it, the phenomenal campaigns, which astonished the thinking men of the military world not less than those of 1866 and 1870, would not have been possible. That this was recognized is shown by the promptitude with which she gathered herself for a superb effort for its attainment, the result of which is attested by the disappearance of her enemy from the water, so far as active operations went, after the fleet action at the mouth of the Yalu. From that date the invasion was a triumphant march, made possible by the decisive victory upon the sea.

If we bring ourselves to a realizing sense of the brilliancy of the Japanese operations which I have attempted to outline, we are at once struck with a desire to know what were the causes which produced such results. We cannot attribute them entirely to the feeble resistance they encountered, which in no way detracts from the soundness of their strategy and tactics. Indeed, some less skillful commanders might have committed the not uncommon fault of underrating the enemy, which would almost have been pardonable. On the contrary, they observed the greatest precaution whether on the march or in bivouac. Like the Germans in their last wars, their patrol system never failed, and as I have said, contributed in no small degree to their success. It is to be regretted that more minute details of the tactics and formations used in attack and defense have not been received, but from the general knowledge we possess of their operations we have every reason to believe them to have been the highest type of modern ideas in that direction.

It is claimed that superior strategic ability, superior organization, and greater activity contributed more to the successful concentration of the Prussian armies and the victory at Königgratz than superior armament. It is also claimed that the victorious campaigns of the Germans in 1870-71 were the result of organization; that they were due to the organization created by Von Moltke, rather than Von Moltke himself,—to the system, not the man. So also were the admirable operations of the Japanese the result of organization—organization and preparation.

The strategic function of an army may be divided into two periods: first, a period of preparation for war, incident to times of peace, embracing a study of the theater of operations and of the resources of the enemy, and the preparation of the plans of

campaigns; then a period of execution, which follows the declaration of war and during which operations are effected according to the plan established, or at least in conformity with a general idea, serving as a basis for the plans of the commander-in-chief, which the more or less unforeseen events of war often modify. The plan formulated by Von Moltke in 1868 unfolded itself in 1870 with almost mathematical regularity and in conformity with settled anticipations.

General Trochu says: "Of all things which contribute most directly and effectually to the success of a military undertaking, *preparation* holds the first place. Without doubt, the genius of the man who conducts the war may sometimes rule its events, but this only in a certain measure and for a limited time. And history tells us that the greatest military geniuses of the world, Caesar and the Emperor Napoleon, to wit, who had so many grounds for trusting alike in their inspirations and their fortunes, did not disdain preparation, on the contrary, that they applied themselves entirely to it and made a thorough study of it as a science from which they hoped great things." In a recent speech, Prince Bismarck, in referring to the wars which led to the unification of Germany, said: "After Sadowa (Königgratz), the principal point with me was that war with the French was not to come too soon, and that we should not be forced to begin it without proper preparation."

Preparation includes, first, a study of the theater of operations and of the resources of the enemy, then the drawing up of a plan of operations and a system of transportation. The strategic importance of a theater of operations often depends upon its topographical characteristics. We have, therefore, two points of view from which it should be examined: first, topographic, having for its aim the study of the features of the ground; second, the strategic, designed to determine their military importance. The task of making a reconnaissance of the theater of operations from this double point of view is one of the most important duties of staff officers.

How thorough had been the work of the Japanese staff is best shown by the remarks of a prominent cabinet minister. When speaking of this war he said: "It has been inevitable for ten years. Steady preparation has been made for it. Every road in Corea and eastern China was surveyed by our War Department

years ago. We had timbers measured and cut for bridges over their streams. Every fort and its armament was familiar to our officers. Our sheet-iron stoves for the soldiers in the winter campaign were made before war was declared. Our transport service was as well organized as our navy, and there were no cartridges made of sand, you will observe, in the belts of our troops."

Under the heading of plans of campaign, Lieutenant-Colonel Fix, in his "Manual of strategy," quotes Colonel Vial, a French writer, as follows: "The study of the part which the ground plays is indispensable before entering upon the campaign. In 1805, when the Emperor foresees the war with Austria, he sends his generals, Murat, Savary, and Bertrand, through Germany under assumed names, charged with studying the ground and reconnoitring the roads, positions, water-courses, mountain chains, bridges, defiles, and means of subsistence. In 1866 the Prussian government, foreseeing the war with Austria, sends a large number of officers to execute similar reconnaissances in Bohemia. Finally, in 1870, everybody remarked the perfect knowledge of our country possessed by the Germans; in many respects they knew our ways of communications, the accidents of the surface and our resources better than we did. All of which shows how advantageous it is to study in advance and with care the ground upon which we are to operate."

A British officer who witnessed the mobilization of the first Japanese army and its transfer to Corea, when comparing it with the Crimea and Wolseley's expedition to Egypt, asserted that such a transport and commissary service had never been seen in the world. The truth is, the Japanese have proved themselves to be masters of the science of logistics.

Even to the minutest detail of the personal comfort of the soldier was their preparation absolutely perfect. In addition to the stoves referred to, their winter uniform was designed to afford the greatest protection against the rigors of a Chinese climate. Every soldier, besides his uniform of heavy dark blue waterproof cloth, was provided with a blanket overcoat, nearly a quarter of an inch thick and approaching felt in density, yet permitting perfect freedom of action. A heavy blanket and several pairs of thickly plaited straw sandals were also provided every man by the clothing department. These sandals, worn outside the ordinary Japanese foot-gear, in this case made of heavy cloth

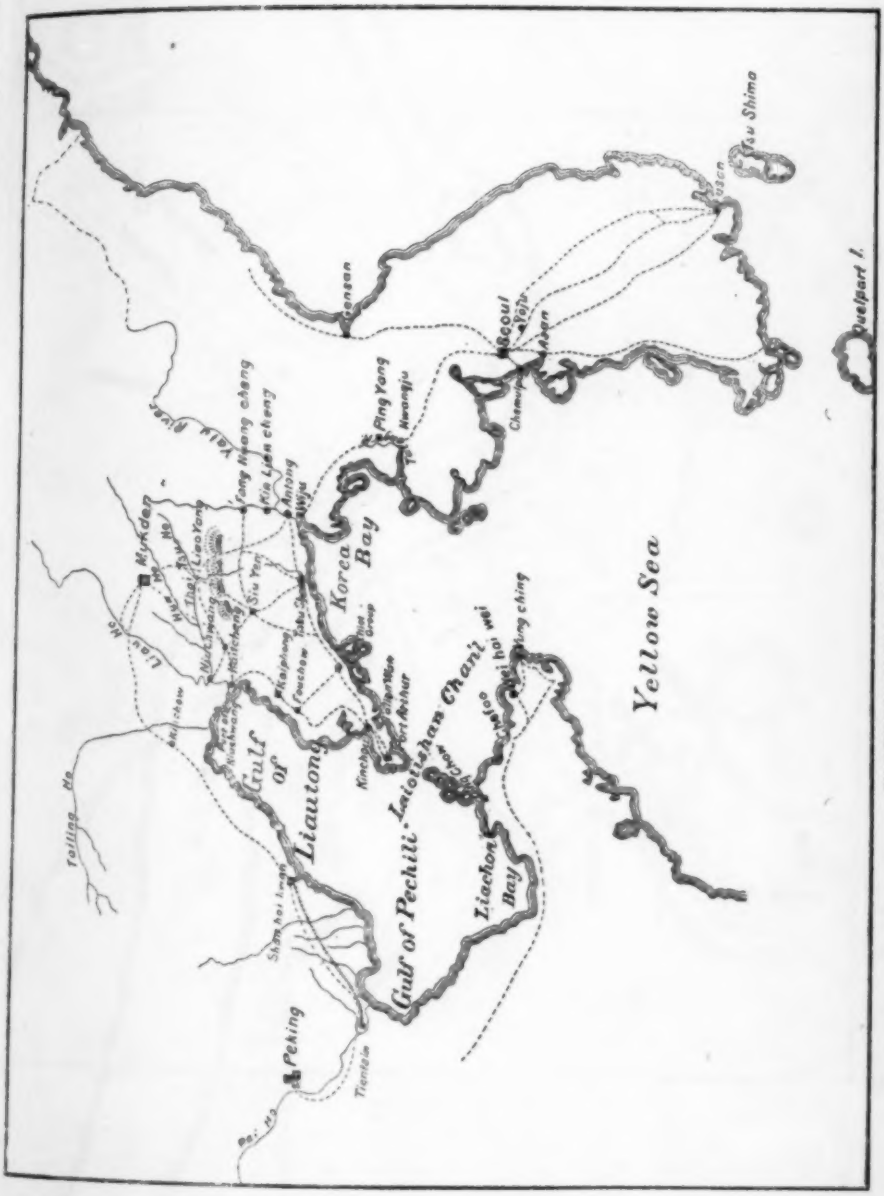
and padded with cotton, proved more effective against the snows and ice than fur socks and riding boots. The military glove, especially designed for this campaign, was the most unique portion of the altogether admirable equipment. This gauntlet was made of flexible felt, yet thick enough to keep out the severest cold of the almost Siberian climate. In form it was an improvement on the old mitten, having a thumb and a place for the index finger, which, midway down it, had a slit with a flap to allow the bare finger to be used to pull the trigger of the rifle. The men were also provided with heavy cloth gaiters. Where do we find a more thorough preparation? It was not surpassed by Prussia in either of her late wars. What a contrast it was to the Crimea with its indescribable sufferings!

The work of the Japanese staff was complete. It left nothing to be desired, and it may be said of it, as has been said of the Prussian general staff, after which it is formed: "This body has become a real element of strength for their army, and has in a large measure contributed to their success, while gaining for itself a justly merited reputation." The Japanese leaders by their work have shown themselves to be models of the highest type of scientific warfare, and I believe that when the official account of this war shall have been written it will be found to have been fruitful in lessons upon the art of war. Already we find the English army at Aldershot practicing night operations with the field telegraph as a medium of communication between the advancing columns. Three brigades engaged in this manœuver on April 19 in presence of the Duke of Connaught, repeating the practice a little later with volunteer troops.

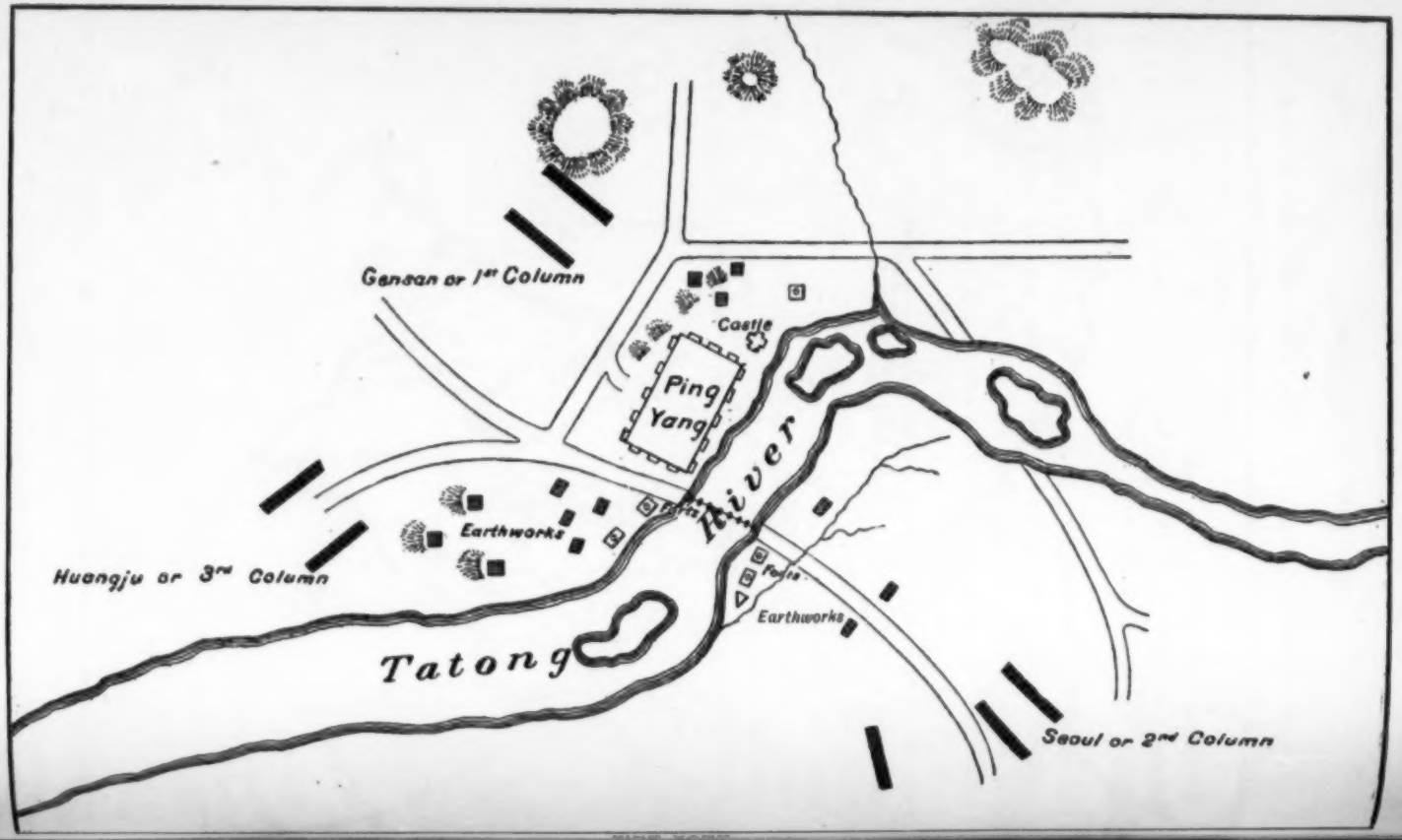
In no portion of that tremendous leap to civilization which Sir Edwin Arnold has called a quiet revolution, has Japan made greater advances than in her military department. Her ambition in the beginning of this remarkable transformation was to possess a complete army corps, armed, equipped, organized and drilled after modern ideas, with transport and supplies ready at all times for instant use, making her a valuable ally to be sought in any contemplated operations in the far East, thus giving her a voice in questions which might involve her interests. How far her aim has been attained may be judged if we realize that when the war began her military resources con-

sisted of three lines of troops,—viz.: with the colors 62,425, first reserve 97,707, second reserve 109,987, total number of troops on war footing 270,119,—and that a combination of three great military nations was deemed none too strong to overawe this plucky little people, who only succumbed to their demands for want of an ally to stand by her side in the fight she was burning to make.

It seems hardly to be realized that a great military nation has been born, ushered into existence amidst the rattle of musketry, the booming of cannon—baptized with fire. This nation, displaying all the best qualities of a warlike people trained to arms, commanded by men who upon the land and upon the sea have proved themselves to be strategists and tacticians of the first order, must no longer be regarded only in the light of tea-houses, quaint art and gentle manners. When the smoke has cleared away, the effect of Ping Yang will be found hardly less violent and far-reaching than Königgratz and Sedan. Japan is at once the England and the Germany of the far East; she is invincible in her island home to any single nation that may come against her.



EASTERN CHINA AND COREA.


Gensan or 1st Column
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Ping Yang
River
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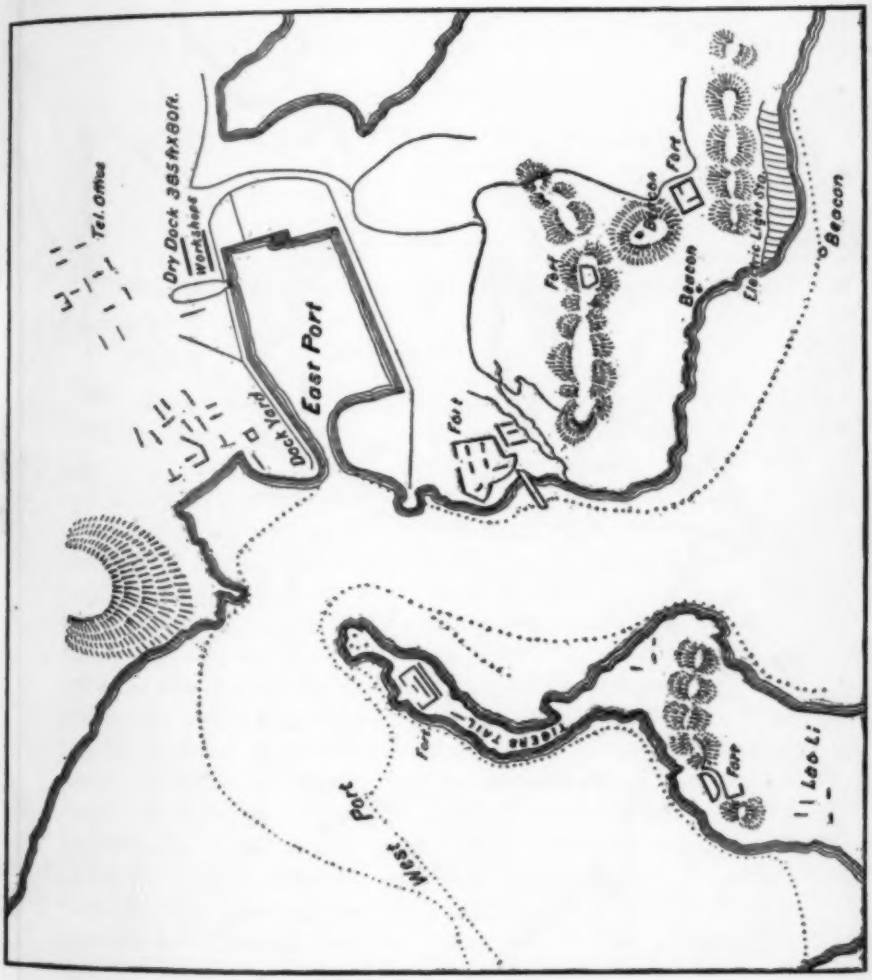
Huangju or 3rd Column
Forts
Earthworks
Tatong
Seoul or 2nd Column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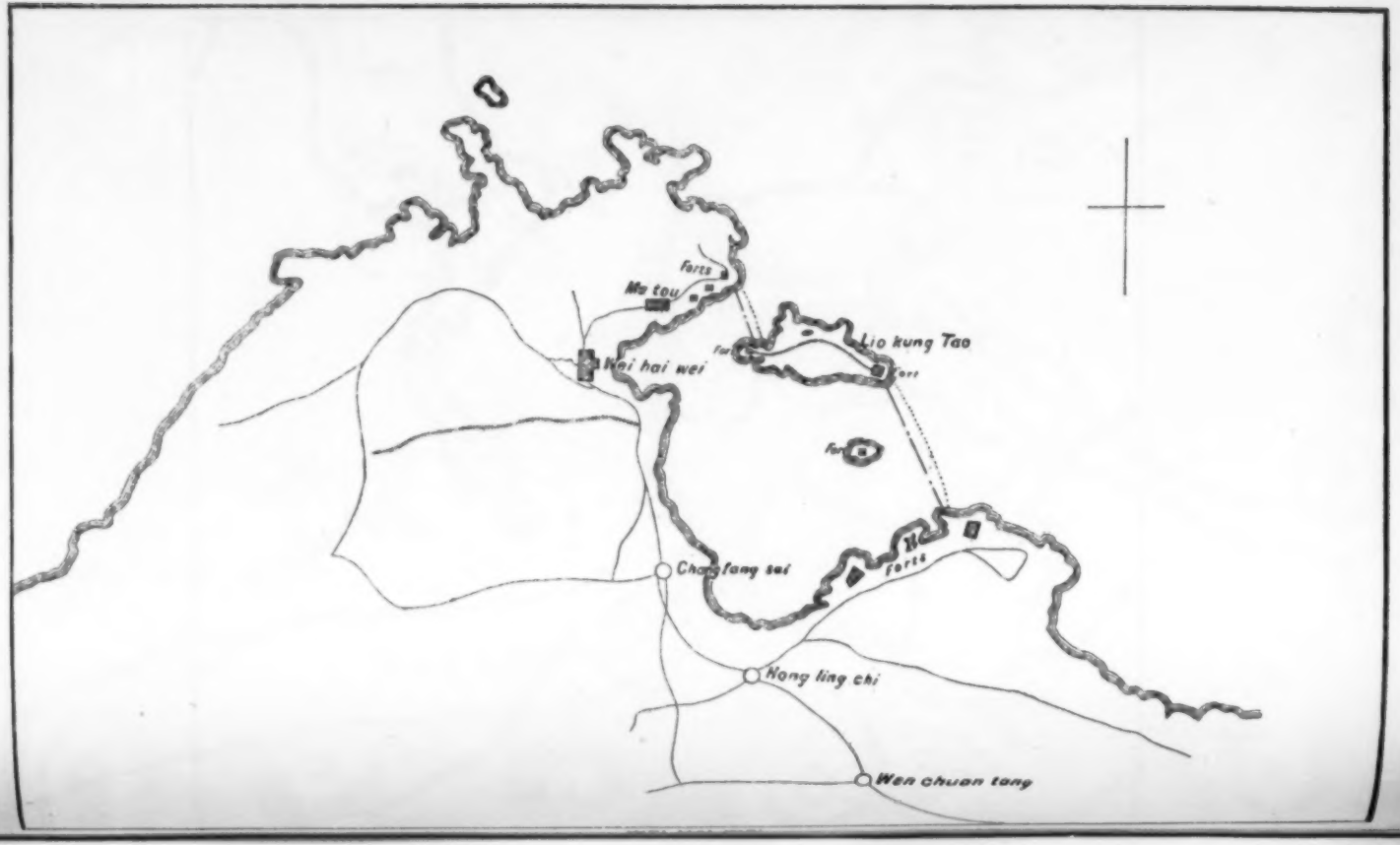
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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

POINTS SUGGESTED BY FLEET DRILL.

By Ensign F. K. Hill, U. S. Navy.

The following criticisms are suggested by our recent squadron manœuvres:*

Conning Tower.

The conning tower is the place from which the captain is to direct a ship's movements in battle; and, logically, he (or his representative) should be there during fleet manœuvres. If the bridge is used in peace (and it is only a peace construction), the officers who have charge will never have the same ready command of the many instruments placed in the conning tower as if they always managed the ship from the tower. To make the case more plain, consider the instruments which are found on the bridge of the U. S. S. New York. (*See list.*) Every officer of the line knows so well where all these instruments are that he can put his hand upon them on the darkest night. This is from constant practice; but, as he rarely enters the conning tower, and never has to use the instruments there, he does not know their location. Hence, if suddenly called to work the ship in action, he would simply be confused. All of our ships with which the writer is familiar have their conning towers so placed that they are almost useless; and, judging by their late war, the Japanese and Chinese were no better off; for the officers state that they could not manœuvre their fleets from the conning tower, and only sought it for safety when engaged at short range.

Closely connected with the manœuvring of the fleet, or ship, from the conning tower is the making of signals. At present,

* North Atlantic Squadron.

as everybody acknowledges, we have no system of *war* signals; and no one in our navy, so far as is generally given out, has proposed any feasible scheme to remedy the present lack. Flags are worthless, yet we still have them. Shapes are proposed, but have never been tried. The writer suggests the following:

A conning tower higher than at present; *no peace bridge, no chart-house,* etc., above the conning tower; but concentric with it, a cone-shaped mast having at its base and immediately over the conning tower a room sufficiently large to manipulate such gear as will work shapes placed on a steel pole projecting from the top of the cone mast. This signal manipulating room should be protected (2″ steel) and in direct communication with the conning tower. On all large ships and battle-ships two of these conning towers and masts would be necessary, and should be connected by telephone. All the necessary instruments mentioned as being on the peace bridge should be placed in the conning tower, and habitually worked from that point.

Surrounding the conning tower, and on a level with it, a bridge should be placed so that the officer-of-the-deck would not be confined to the limits of the conning tower; and also such shutters should be furnished to the conning tower as might be kept open in ordinary cruising to give better sight and air to the helmsman within.

Now as to the Fleet.

Practically in all fleet battles of the future, the speed will be at least fifteen (15) knots; therefore fleet tactics should be carried on at that speed. The judgment and practice acquired by handling a fleet at a speed of nine (9) knots are almost useless when the speed is increased to fifteen (15). The times at which the guide ship (in such movements as "forward into line, left oblique") should go ahead full speed are different for different speeds. The helm angles differ, as do many other minor points connected with the proper maintenance of the exact bearings and distances of the various ships. Why should we learn to manœuvre at nine (9) knots when we will have to throw away practically all ideas gained when we go into actual battle, or shall have to run at a low speed, which will place us at a great disadvantage? Of course, the first few days of drill with a new fleet might be at a low speed for safety; but the speed should be rapidly increased until actual war speed is obtained.

Closely connected with the speed and manœuvring ability is the question of having the ships of a fleet as nearly as possible alike. Nearly every ship we have is slightly different from all others. Each one as it is built is the latest and best thing out, we are told. But would it not be better if we considered what ships are to do, and tried to make our fleets homogeneous? By this I do not mean that we are not to progress; but would it not be better to have some tactical unit, say four (4), and then let the vessels be built to form tactical units? Thus four (4) consecutive ships of a particular class would be exactly alike, built for a certain duty and station; and the next four (4) for some other duty and station, and so on. This would be particularly desirable in battle-ships, which remain at home and which should be grouped as a squadron and exercised together; so that when combined with another group of four (4) to form a fleet, there would only be a case of assimilating two (2) groups instead of eight (8) independent vessels, all of different characteristics. These groups of four (4) should all be exercised together when first commissioned, and then detailed to the same station, after which, with a certain amount of fleet drill at stated periods, they could be kept in a high state of efficiency. As an example of the results of such training of similar vessels, it may be stated that in the German navy they have units of torpedo-boats (seven (7) in a group) which are able to steam at full speed in echelon, while each vessel is in touch with its neighbors. Another argument for the group system is that if four (4) similar vessels are fighting together, the line of bearing on which any one can fight advantageously will be the same for all the others.

Personnel.

The time that our admirals serve as commanders-in-chief is so brief that they hardly get into working condition themselves before they are either relegated to the retired list or go on some shore duty. The cause of this trouble is that the slowness of promotion in the line has caused our officers to pass a great length of time in the lower grades and but a short time in the command grade. We even go to the extremity of making commodores do admiral's work, calling them acting rear admirals and giving them commodore's pay.

This shows that we should have more officers in the upper grades, and that such legislation should be enacted as would cause the time spent in the various grades to be more nearly equalized than at present.

As an example of the bad results of the present condition of affairs, it may be stated that on the home station, where most of the fleet drills are expected to take place, there is an average of one (1) new commander-in-chief each year, with frequent cases in which the admiral remains in command for a few months only.

The commanding officers are not changed quite as often as the admirals, but even they frequently do not remain long enough to get the best results out of their respective ships. In addition to this, the commanding officers (or their representatives) do not handle their ships in fleet tactics as if in battle (for reasons stated in connection with the conning towers); and the writer, having served on five (5) of our modern cruisers, never knew but one commanding officer who went into the conning tower at great gun drill and from there controlled the battery; and even that one did not make a practice of going there.

The remedy for this is for the commanding officers to take their position during drill or gun practice in the place assigned them in battle, and from there to control the guns as if in battle; for certainly the captain should have drill and preparation as well as the divisional officers. After the captain has thoroughly drilled the ship, would it not be wise to imagine certain casualties, and allow the command to devolve on some of the other officers, giving each a turn, down to the lowest ensigns?

As for the watch officers, they always have their regular stations at drill and target practice, and are there as if for battle; and the only suggestion in regard to them is the one above, that they should succeed the captain in command and be drilled at his station.

There is but one test for all our exercises, viz., "Are they carried out as if in battle?" If they fail in that, they should be dropped or *changed* so as to stand the test.

LIST OF INSTRUMENTS ON BRIDGE OF THE U. S. S. NEW YORK.

1 telephone.
5 speaking tubes.

4 electric buttons.
4 annunciators.
2 speed indicators (electric).
2 speed indicators (mechanical).
1 revolution indicator.
1 helm indicator.
2 electric tickers for revolution indicators.
1 helm telegraph.
2 mechanical indicators for revolutions.
1 automatic push-button for fog signals.
3 push-buttons with clock attachments for automatic working of siren, whistle and search-light.
1 Ardois signal-box.
4 control stands for search-lights.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

TESTS OF SOUTHERN COALS.

By Lieutenant H. S. Knapp, U. S. Navy.

The Bureau of Equipment has prepared a publication giving the results of many steaming trials of different varieties of coal, domestic and foreign, made by naval vessels. Among them appear the results obtained by the Montgomery during the past winter, while she was engaged in testing Southern coals from the fields in northern Alabama and southeastern Tennessee. As these tests were all made by one ship under circumstances as closely alike as possible, and the coals all came from the same general locality, it may be of interest to publish these results in the Proceedings in a separate and more detailed form. They will be found below, largely in tabular form; but the remarks supplementary to the tabulated data are quite as important as those data themselves in forming a correct estimate of the steaming value of the different coals for naval purposes.

For each test the operators furnished, free of charge, 75 tons of the particular variety; in addition, enough more of the same sort was purchased to provide for raising steam and getting in and out of port, for working auxiliaries, and for possible contingencies, thus ensuring the full 75 tons for the test proper.

The tests were each made in three parts, at speeds of 135, 120 and 100 revolutions respectively, burning 25 tons at each speed. At the start the speed was gradually worked up to 135 turns; when running smoothly, with sufficient steam making, the test began. As soon as the first 25 tons were burned the speed was at once reduced to 120 turns, and the fires worked to give the necessary power, cutting off one boiler if possible. When the second 25 tons were consumed the speed was immediately

reduced to 100 turns, and the boiler power manipulated as before, until the end of the test.

Before each test the engines were overhauled and the bearings adjusted. The boilers were also carefully overhauled and cleaned; the tubes were swept, and a thorough examination made inside and outside to discover signs of any injury that might have resulted from the use of the coal previously tested. Salt feed was used only as necessity dictated.

During the intervals between tests the ship lay at Mobile, in fresh, or brackish water, excepting in two instances. Once, between tests Nos. 3 and 4, coal was taken at Pensacola, where the ship was six days in port; again, between tests Nos. 7 and 8, the ship was on detached duty in Caribbean waters for a little over a month, but the stays at any one place were short, and the bottom was not believed to have fouled materially in consequence. In fact, the highest speed was attained at 135 turns on the last test made.

In the table the tests are numbered consecutively as they were made, and the remarks supplementary to the tabulated results are given by reference to the number of the test. The I. H. P. was determined from three sets of cards, one set taken at each speed after conditions had become permanent, and when running at the prescribed speed, if possible. The I. H. P. of the auxiliary machinery was estimated at 62 throughout all the tests. The speed and distance run were determined by patent log, checked by observation.

The Montgomery has three double-ended main boilers, designated A, B and D, and two single-ended auxiliary boilers, C and E, all of the cylindrical return-fire tubular type. The principal data concerning them are given below.

Diameter, all		11′	8″
Length	A and B	18′	
	D	18′	8½″
	C and E	9′	0½″
External diameter of tubes, all			2¾″
Length of tubes	A and B	6′	3¼″
	D	6′	7″
	C and E	5′	11¼″
Number of furnaces	A, B and D	4	
	C and E	2	
Greatest internal diameter of furnaces, all			44⅞″

Length of grates	A and B	86″
	D	89½″
	C and E	82¼″
Grate surface	A and B, each	84.28 sq. ft.
	D	88.32 sq. ft.
	C and E, each	39.70 sq. ft.
Heating surface	A and B, each	2734.79 sq. ft.
	D	2871.20 sq. ft.
	C and E, each	1318.65 sq. ft.
Greatest width of combustion chamber,* all		4′ 10½″
Greatest height of combustion chamber, all		7′ 0½″
Depth of combustion chamber	A, B and D	2′ 4¾″
	C and E	2′ 4″
Internal diameter of chimney		5′ 8″
Height of chimney above grate bars		60′

Synopsis of Remarks.

Trial No. 1. Coal easily stowed. Requires considerable working to make it burn efficiently, as it cakes soon after slicing and makes a considerable quantity of clinker. Half of the fires require cleaning every watch, and tubes require sweeping every 36 hours. Fires were very dirty in 8 hours from the time they were started. Owing to dirty fires it was impossible to maintain 135 revolutions after the first three hours of trial. Showed lack of efficiency at high speed test. Formed great quantities of smoke. Good for blacksmith's use. No injurious effect observable on boilers.

Trial No. 2. Coal easily stowed. Requires moderate amount of working to make it burn efficiently; the amount of clinker was not excessive, but appeared to stick firmly to the grate bars and was difficult to remove. Owing to dirty fires it was impossible to maintain 135 revolutions after four or five hours. Tubes require sweeping every 36 hours. Formed great quantities of smoke. No injurious effect observable on boilers. By a mistake, not observed until too late, the test at highest speed was closed when only 23.46 tons had been consumed.

Trial No. 3. Coal easily stowed. Requires little working to make it burn freely, the clinker being small in quantity and easily removed. Revolutions easily maintained. Formed great quantities of smoke. Tubes require sweeping every 24 hours. During highest speed test flame issued continuously from both stacks, heating them and the uptakes to a dangerous extent; and sparks fell in great quantities on deck, making it necessary to wet decks

* There is a separate combustion chamber for each furnace.

Consecutive number of Test.	Style of Company Furnishing Coal, and Name of Coal.	Part of Test.	Duration, in Hours.	Area of Grate Surface.	Boilers Used.	Fuel, in Pounds, Consumed per Hour.	Per Cent. of Refuse.	I. H. P. of Main Engines.	Fuel, in Pounds, Burned per I. H. P. per Hour.	Knots per Ton of Coal.	Speed.	Revolutions. Starboard.	Revolutions. Port.	Revolutions. Mean.	Knots Steamed.	Character of Smoke.	Hours Necessary between Cleaning Tubes.	Condition of Bottom.	Days out of Dock.	Wind. Force, Beaufort Scale.	Wind. Direction, Degrees from Ahead.	Condition of Sea.	Estimated Effect of Wind and Sea on Speed.	Draught. Before Test. For'd	Draught. Before Test. Aft.	Draught. After Test. For'd	Draught. After Test. Aft.
1	Sloss Iron and Steel Co. "Sloss."	1st	10.65	296.58	ABCD	5258	11.16	2109.14	2.42	6.452	15.15	130.1	129.2	129.65	161.3	Grayish Black.	36	Good.	40	3-4	0-167	Smooth.	None.	13′ 9″	16′ 0″	12′10″	16′ 0″
		2nd	11.35	296.58	ABCD	4934		1401.90	3.175	6.584	14.5	119.6	118.3	118.95	164.6				41	3-4	135-90	Smooth to Heavy.	None.				
		3rd	19.	208.26	ABC	2947		1183.62	2.366	8.604	11.3	99 92	99.99	99 995	215.1				41	3-5	169-51	Moderate.	None.				
2	Tennessee Coal, Iron and Railroad Co. "Pratt."	1st	10.75	296.58	ABCD	4887	9 46	2318.82	2.06	7.216	15.56	132.49	132.43	132.46	169.3	Grayish Black.	36	Good.	50	3-2	128-15	Light Swell.	None.	13′10″	16′ 3″	12′ 6″	16′ 0″
		2nd	12.	296.58	ABCD	4667		1552.99	2.89	6.908	14.4	120.01	120.00	120 005	172.7				51	2-4	37-127	do.	None.				
		3rd	19.8	208.26	ABC	2828		936.53	2.88	9.436	12.08	100.11	100 02	100,065	235.9				51	5-2	107-25	do.	None.				
3	Mingo Mountain Coal and Coke Co. "Mingo."	1st	7.8	296.58	ABCD	7179	6 01	2371.87	2.95	4.88	15.61	135.07	135.53	135.3	121.8	Grayish Black.	24	Good.	65	1	.....	Smooth.	None.	13′10″	16′ 4″	12′ 3″	16′ 3″
		2nd	11.2	296.58	ABCD	5000		1662.36	2.90	6.20	13.83	120.	120.	120.	154-9				66	1-2	135	do.	None.				
		3rd	18.5	208.26	ABC	3027		884.48	3.20	8.62	11.7	100.	100.05	100.025	215.5				66	2	135-0	do.	None.				
4	Tennessee Coal, Iron and Railroad Co. "Cahaba."	1st	9.5	296.58	ABCD	5894.74	7.0	2338.95	2.455	5.488	14.44	134.6	135.2	134.9	137.2	Dark Gray.	48	Good.	73	4-5	33	Moderate.	0.5 loss.	13′ 8″	15′ 8″	12′ 8″	15′ 6′
		2nd	12.2	256.88	ABD	4590.16		1737.75	2.550	7 072	14.45	120.	120 04	120,02	176.8				74	4-5	33-135	do.	None.				
		3rd	18.8	†168.56 ‡208 26	AB ABC	2978.73		864.33	3.107	8,988	11 96	99.99	100.02	100.005	224.7				74	2-5	120-55	Smooth to Mod.	None.				
5	Standard Coal Co. "Millidale."	1st	9.5	296.58	ABCD	5895	8.94	2199.17	2.607	5.934	15.61	135 1	135.	135.05	148.4	Grayish	60	Slightly Foul.	88	3-4	120-140	Moderate.	None.	13′11″	15′11″	12′10″	15′11
		2nd	12.	296.58	ABCD	4667		1744.34	2.584	6 536	13.6	120.2	120.1	120.15	163.4				89	5-6	11	do.	1.0 loss.				
		3rd	16.5	208.26	ABC	3062,8		927.46	3 302	8.644	11.8	100.	100.	100.	195.				89	4-6	11-180	Smooth to Mod.	None.				
6	Southern Jellico Coal Co. "Jellico."	1st	* 8.5	296.58	ABCD	5797.61	5.7	2249.60	2.508	5.879	15.21	135.17	135.	135.085	*129.3	Grayish Black.	60	Slightly Foul.	94	1	.....	Smooth.	None.	13′ 9″	16′ 2″	12′ 6″	15′11″
		2nd	* 9.25	256.88	ABD	5054.36		1488.38	3.217	5 909	14.05	119.955	119 98	119.967	*130.				95	1	.....	do.	None.				
		3rd	*15.05	168.56	AB	3277.34		928.35	3 309	8.077	11.8	100 05	100.004	100.027	*177 7				95	1	.....	do.	None.				
7	Corona Coal and Coke Co. "Corona."	1st	7.5	296.58	ABCD	7466.66	16.69	2113.90	3 432	4.468	14.9	133.465	133.955	133.71	111.7	Grayish Black.	24	Slightly Foul.	108	1	50-150	Smooth.	None.	13′10″	16′ 2″	12′ 6″	16′ 2″
		2nd	9.75	296.58	ABCD	5743.57		1689.09	3.28	5,468	14.	120.08	120.04	120.06	136.7				108	1	150-90	do.	None.				
		3rd	14.5	212.30	ACD	3862.07		971.80	3 736	6.84	11.79	100 312	100.	100,156	171.				109	1	Var.	Smooth to Mod.	None.				
8	Pearson Coal and Iron Co. "Pearson-Warrior."	1st	9.03	296.58	ABCD	6222.22	9.36	2267.10	2.676	5.64	15.32	135.	135.	135.	141.	Dark Gray.	60	Slightly Foul.	155	2	22-75	Smooth.	None.	13′ 8″	16′ 8″	12′ 6″	16′ 6″
		2nd	11.97	256 88	ABD	4656.66		1800 75	2.505	6.52	14.5	120.	120.	120,	163.				155	3	45-68	Smooth to Mod.	None.				
		3rd	15.33	172 60	AD	3733.33		933.32	3 735	7.268	11 09	100.	100.	100.	181.7				156	4	26-149	Mod. to Smooth.	None.				
9	Virginia and Alabama Coal Co. "CoalValley."	1st	7.75	296 58	ABCD	7225.80	10.02	1948.30	3 594	4.94	15 9	131.6	129.6	130.6	123.5	Dark Gray.	60	Slightly Foul.	162	1-2	15-117	Smooth.	None.	13′ 8″	16′ 8″	12′ 6″	16′ 9″
		2nd	9.	296.58	ABCD	6222.22		1376.42	4.356	5.06	14 05	120	120.	120:	126.5				163	2-4	29-117	Smooth to Mod.	None.				
		3rd	15.	168.56	AB	3733 33		962.32	3.645	7.124	11.87	100.	100.	100.	178.1				163	1-4	5-107	do.	None.				
10	Tennessee Coal Co. "Cripple Creek."	1st	8.25	296.58	ABCD	6787.87	10.75	2226.37	2.967	5.428	16.2	135.	135.	135.	135.7	Dark Gray.	60	Slightly Foul.	171	2-3	42	Smooth.	None.	13′20″	16′ 4″	12′20″	16′ 6″
		2nd	11.33	256.88	ABD	5090.90		1531 59	3.194	6.888	12 9	120.	120.	120.	172 2				172	1-4	11-56	do.	None.				
		3rd	16.00	168.56	AB	3360.00		944.39	3.338	7 600	11.4	100.	100	100.	190.				172	2-4	0-140	do.	None.				

‡ For 21 hours.
† For 5.4 hours.

* Only 24 short tons were furnished for this test, which was therefore made by burning 52 long tons at each speed. Correcting the column "Knots Steamed" in proportion as 52 to 56, the values will be 144.8, 149.2 and the respective mean

and boat-covers for safety. At the lower speeds neither flame nor sparks issued from stacks. The boilers were uninjured, but the turret smoke pipes and uptakes were warped so that two forward dampers could not be closed.

Trial No. 4. Coal easily stowed. Burns freely with a very little working, but when necessary to force the fires on account of limited grate surface it burns poorly, as it will not stand much working. Clinker is moderate in quantity, but adheres to bars and is removed with difficulty. Formed moderate amount of smoke. Tubes required no sweeping during test, and only moderately dirty after test ended. 135 turns were maintained without difficulty, and at beginning of 120-turn test fires were allowed to die out under auxiliary boiler; at beginning of 100-turn test allowed fires to die out under boiler D, but difficulty was found in keeping steam, and fires were again started under the auxiliary boiler C. No bad effects observable on boilers.

Trial No. 5. Coal easily stowed. Mostly fine coal, the lump not exceeding 15 per cent. Caked readily when thrown on fires and burned freely with moderate amount of working; the amount of clinker moderate and easily removed. Revolutions kept up without difficulty. Fires did not require cleaning in the first twelve hours, and after that one-third of the fires were cleaned every watch. Tubes did not require sweeping during tests, and were only moderately dirty at end of tests. Formed a moderate amount of smoke. Boilers uninjured by use of this coal. Low speed test was stopped by fog when 22.56 tons had been burned, and speed during second test was greatly reduced by wind and sea.

Trial No. 6. Coal readily stowed. Burned very freely, with little or no working to keep required pressure, and with the formation of very little clinker and refuse. Formed a considerable quantity of smoke. Tubes did not require sweeping during tests, and were in fair condition at their termination. No bad effects observable on boilers. Short tons were furnished, so tests were conducted with 22 long tons burned at each speed. After arrival in port, all three blades of port propeller and one of starboard propeller were found bent, caused by hitting sunken logs in Mobile Channel.

Trial No. 7. Coal readily stowed. Consists of about 20 per cent. fine coal, rest lump. During high speed test it was impos-

sible to make required number of revolutions, the fires being very dirty. Coal would not make sufficient steam without working, and when worked great quantities of clinker were formed; clinker was easily removed. Necessary to clean fires four hours after test began, and one-half of the fires were cleaned each watch thereafter. Tubes were nearly closed at end of tests. Great quantities of smoke were formed. No injurious effect on boilers observable. Propellers in same condition as in trial No. 6.

Trial No. 8. Coal easily stowed, being mostly fine coal with not more than 15 per cent. lump. Burned freely with moderate working, and revolutions were maintained without difficulty. Clinker moderate in amount and easily removed. Tubes did not require sweeping during tests, and were not very dirty at finish. Smoke only moderate in amount. Boilers uninjured by test. Propellers in same condition as in trial No. 6.

Trial No. 9. Coal easily stowed, containing about 60 per cent. of lump. During high speed test it was impossible to maintain the required revolutions. The fires were very dirty after four hours. For efficient work half the fires would have to be cleaned each watch. Considerable clinker and a large volume of smoke formed. Tubes were not swept during tests, and were found moderately dirty at their conclusion. No bad effects were observed on boilers. Propellers as in trial No. 6.

Trial No. 10. Coal about 50 per cent. lump, some of the lumps very large; easily stowed after breaking up the large lumps. Burned freely with small quantity of clinker. The required revolutions were maintained without trouble. When fires were worked flames issued from both stacks, burning off the paint. Volume of smoke not excessive. Not necessary to sweep tubes during test; at conclusion they were only moderately dirty. Boilers uninjured by test, but uptakes and inner stacks were slightly warped by excessive heat. Propellers as in trial No. 6.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ARMOR FOR SHIPS OF WAR.

By PROFESSOR P. R. ALGER, U. S. Navy.

Before entering upon a discussion of the uses of armor and the considerations which should govern its distribution in ships of war, it will be well to briefly outline the history of its introduction and development and describe modern methods of its manufacture.

It was the introduction of shell-guns which rendered wooden walls, and even iron hulls without armor, impracticable for war vessels, and the signal instance of their effect in the annihilation of the Turkish fleet at Sinope first showed the necessity of providing some protection against their destructive fire. To John Stevens, of Hoboken, N. J., belongs the credit of originating the idea of applying armor to the sides of ships, but the French first gave this idea practical shape in the floating batteries which, on October 17, 1855, silenced the Russian forts at Kinburn. The cuirass of ancient times was restored, but instead of defending the breasts of single warriors from hostile spears, it was expanded over whole frigates—their armament, men and machinery, and thickened to resist shells and even solid shot.

But the superiority of the defense was short-lived, and the introduction of new weapons of attack and the continued advance of artillery in weight and power soon forced a corresponding development of armor.

For some years manufacture of armor was limited to plates of small area, and imperfect welds and steely spots, as well as great irregularity in quality, were necessary evils owing to imperfect appliances for the production of thick plates. Laminated plating, when tried, was found greatly inferior to the same thickness in

a single plate. In 1859, however, armor manufacture had so far developed that French 4¾-inch plating proved superior to the attack of the 68-pdr., then the most powerful naval gun, and in 1860 the English report "vessels clothed in rolled iron plates 4½ inches thick are to all practical purposes invulnerable against any projectile that can at present be brought against them at any range." But the general adoption of rifled guns on the Continent and the introduction of the 11-inch and 15-inch smooth-bore guns in the United States called for renewed exertions on the part of the armor makers, and in 1867, it being still impossible to produce plates of reliable quality more than 6 or 7 inches thick, the plate upon plate system, in which several thick plates were superimposed, was tried and proved superior, in the then state of the art, to the solid plate of equal thickness. In 1868 plates over 8 inches thick were tested, and in 1872 12-inch plates were tested both in England and Prussia, and, though of good quality, were hardly a match for the guns brought against them. Such had been the development of the artillery with which armor had to contend that while, as late as 1863, 4½-inch plating made a ship invulnerable, in 1868 it took 9-inch plating, and in 1872 a 12-inch plate was pierced on the firing ground. With the introduction of 12-inch plates the limit of regularity in manufacture with wrought iron seemed to be reached, and the cost of the plate upon plate system, owing to difficulty in making the plates fit each other, led to the trial and adoption of the sandwich system, in which layers of wood separate the two or more plates making up the complete target. The first application of this system was to the English ship Dreadnaught, whose turrets, built up of two 7-inch plates, separated by 9 inches of teak and secured to a backing of 6 inches of teak and two ¾-inch skin plates, were considered more than a match for the 12-inch rifle. But the advent of the 14¼-inch Krupp rifle in 1875 and the 81-ton Woolwich gun in 1876 marked the final supremacy of the gun. Wrought-iron armor had now reached its highest development in the Inflexible, whose armor consisted of two layers of 12-inch plates with 11 inches of teak between, backed by 6 inches of teak and two 1-inch skin plates. Simultaneously with the adoption of this armor disposition the Italian government, desirous of building the most powerful ships in the world, called for competitive tests of 22-inch armor, and two French and two English

firms having submitted plates, in 1876 took place the famous Spezzia trials which revolutionized armor manufacture in Europe. The plates submitted were solid wrought iron, sandwich wrought iron, sandwich with wrought-iron face plate and cast-iron rear plate, and solid steel, the latter made by Schneider & Co. of France. The guns used were the 10-inch and 11-inch Woolwich rifles and the Armstrong 100-ton gun. The Italian commission condemned the types containing cast iron as of relatively feeble defensive qualities; stated that the remarkable advantages realized with the single plates left no doubt of the superiority of this disposition over the sandwich, and concluded that the most advantageous disposition of armor was embodied in the solid steel plate, this having kept out all shot, although wrecked thereby, while the iron targets were pierced by the shot from the 100-ton gun. Thin steel plates and iron plates faced with steel had ere this been tried in England with doubtful success, but it was now recognized that the day of wrought iron had passed, and attention was at once turned to the production of armor having the resisting qualities of the Schneider plate without its brittleness. In August, 1887, the first of what are known as compound plates was tested at Shoeburyness, England. This plate, made by casting a steel face upon a wrought iron back and rolling the whole to a thickness of nine inches, was tested with the 7-inch rifle, the penetration being but $3\frac{1}{8}$ inches, whereas in a wrought-iron plate it would have been fully 8 inches. In another year 9-inch compound plates, now adopted for the Inflexible's turrets, resisted the 9-inch rifle, so rapid was the development of the new system, and in 1880 the manufacture of both compound and steel armor had so progressed that they were brought into close competition. In 1882 the Italian government again invited armor makers to submit plates to test in order to determine the best system for use on the Lepanto; and Cammel & Co. and Brown & Co., of England, the foremost makers of compound armor, and Schneider & Co., of France, the leading makers of steel armor, each submitted a plate 18.9 inches thick. Two shots from the 100-ton gun wrecked each compound plate, while the steel plate, after three, still covered the greater part of its backing, the commission concluding that the Schneider plate was superior to the compound plates and better adapted to protect a ship's side. Steel plates were not always victorious, however, for in several trials, notably

that at Ochta, in 1882, the compound plate proved the better, and the less cost and more rapid development of this system in England led to its exclusive use there and its general adoption on the Continent during the next ten years. The demand for steel armor was, however, sufficient to continue its development, and its increasing superiority was so demonstrated by various tests that when the United States, in 1886, had before it the task of domesticating the manufacture of heavy armor, the decision as to the preferable material was not doubtful, and steel armor was ordered for all the armored ships then authorized by law. In 1890 the first public trial of a new material for armor—steel alloyed with nickel—took place at Annapolis, Md., a competitive test of a Cammel compound, a Schneider steel and a Schneider nickel-steel plate being held by the Navy Department. The compound plate proved inferior in a marked degree to the others, and the nickel-steel showed a remarkable resistance to cracking. In the same year a steel plate hardened on one face by a process of superficial carbonization was also tried at Annapolis and showed phenomenal resistance to penetration. In 1891 the U. S. Navy Department tested three plates made by the Bethlehem Iron Company of Pennsylvania by the usual forging process, and three made by Carnegie, Phipps & Co., of Pennsylvania, by rolling in a heavy plate-mill. Five of these plates were of nickel-steel and three had been surface-hardened, or Harveyed, as it was called, from the inventor of the process. This test demonstrated that good armor of moderate thickness can be made by the rolling process, a fact of considerable importance—that the nickel-steel plates made in the United States were markedly superior to any armor that had been publicly tested abroad, and that the process of surface-hardening offered a probable means, after some difficulties were overcome, of greatly increasing resistance to perforation.

As a result of these trials, our Government at once adopted nickel-steel Harveyized plates for the armor of all its ships, and within a very short time the use of surface-hardened steel, either simple or nickel, became general abroad, compound armor going out of use entirely.

The following is a brief description of the method of manufacturing armor used in the United States. The ingot, of approximately rectangular cross-section and about twice the weight of the finished plate, is made of open hearth steel, sufficient nickel

being added to the furnace charge to produce about 3¼ per cent. in the final cast. After cooling, the ingot is stripped, reheated and forged to the required dimensions, the first operation being forging the upper end into a porter bar for handling, and the entire forging operation usually requiring several heats. Either an immense hammer or a hydraulic press may be used for forging, but the latter is considered preferable, both as regards manufacturing economy and superiority of product. The Bethlehem Iron Company have both a 120-ton hammer and a 16,000-ton hydraulic forging press; the Carnegie Company have a similar press and rolls, the latter being used at present only for thin plates (9 inches or less in thickness).

After forging, the upper end of the plate is cut off under the press or hammer, and the remainder, after cooling, is trimmed to size by a saw or planer. It is then placed in the Harveyizing furnace with its back and sides well protected by refractory materials and its face covered with the carbonizing mixture, is heated to a high temperature and allowed to soak for several days. When the hardening material has penetrated sufficiently into its face, the plate is removed from the furnace. It is then reheated, bent to the required curvature under the hydraulic press, again heated and allowed to cool slowly to remove the strains caused by bending. Occasionally, when the curvature is slight, plates are bent before being Harveyized; usually they are bent after Harveyizing, though before tempering. The Harveyizing operation merely consists in putting carbon into the face of the plate, and it is not until after the tempering process that this face becomes hard and brittle.

The next operation consists of heating the plate and chilling its surface with a spray of cold water, which hardens the highly carbonized face, but leaves the body of the plate still soft.

Finally the curvature is rectified under the press at a low temperature, not sufficient to soften the hard face, and the bolt holes are bored and tapped. The face of a Harveyized plate, after tempering, is so hard as to resist any tool, and when bolt-holes are required to be bored in the hard face for structural purposes an ingenious process of annealing, or softening, by an electric current has been devised and is in successful use.

Armor was first applied to wooden ships, but when iron and steel ships succeeded these it was found necessary to interpose

a certain thickness of wood between the skin plating of the ship and the armor to decrease injury to the ship's side from impact of shot, and to provide a surface that could be trimmed to exactly fit the plates as manufactured. This backing is of oak or teak, and in modern ship design is usually of moderate thickness. At first much trouble was experienced with fastenings, the through bolts originally used causing leaks and snapping at the bottom screw-thread when the plate was struck. These defects were remedied by using bolts like wood screws extending not quite through the backing. The bolts now used are of forged steel, pass through the skin plating and backing and screw into the plate from two to three inches; they have shanks of reduced diameter to prevent breaking at the thread, are packed with hard rubber to prevent leakage around them, and have rubber washers under the nut heads. With steel armor one bolt is used to about every $4\frac{1}{2}$ square feet of plate, and the diameters vary from $1\frac{1}{2}$ inches for thin plates to $3\frac{1}{2}$ inches for thick plates.

Whatever may have been the case in the past, it is safe to say that with the armor in present use wooden backing adds nothing to the resistance, and its only advantage is the supposed distribution of the shocks of impact over a large area of the plating behind armor due to the close fitting surfaces rendered possible by its use. It is to be hoped that the use of wooden backing will be entirely abandoned in future construction.

Putting aside for the moment the consideration of the increased resistance resulting from the surface-hardening processes now in general use, let us see what has been the outcome of the thirty years' development of guns and armor since 1860, when the $4\frac{1}{2}$-inch iron plate was declared invulnerable to any gun afloat. To-day such a plate would be easily perforated by the projectiles of the 4-inch gun at 2000 yards' range, and at point-blank by the 6-pounder, and the best nickel-steel armor-plate must be almost twice the calibre of the gun attacking it in order to resist perforation at point-blank with normal impact and the best quality of armor-piercing shell. Even at fighting ranges the heaviest armor now in use will be no match for the 13-inch gun, provided the impact is nearly normal.

Five years ago the gun seemed to have finally and definitely attained supremacy, when suddenly and most unexpectedly the surface-hardening process was found practicable, and at once

armor development appeared to take an immense stride forward. A 6-inch plate so treated has shown itself invulnerable to the attack of the 6-inch gun, a 14-inch plate to the 10-inch gun, and a 17-inch plate to the 12-inch gun. What is the cause of this change in the relative powers of attack and defense, and is the present relation likely to be an enduring one? I believe not. Years of development resulted in the production of forged steel shell which, being capable of withstanding the tremendous strains of impact upon steel plates without injury or practical distortion, delivered the entire energy of their blows upon the plates and pierced them. These projectiles, when called upon to meet the still greater strains of impact upon hard-faced armor, broke into fragments, dissipating a large part of their energy in heat and useless work, and consequently failed to penetrate. Only when their velocity was so great as to cause their broken fragments to tear through was the Harveyed armor pierced. But already we are perfecting our projectiles to meet the new demands, and there is no reason to doubt that in the course of time they will be produced of such a quality as to endure impact at high velocity upon the hardest surface. Experimental shell have been tested at the Indian Head Proving Ground which passed through Harveyed plates without distortion, and it has been shown, in my opinion, that with such projectiles the hard-faced armor is not greatly more resisting than the homogeneous nickel-steel armor it has superseded.

But if guns now overmatch all practicable armor, and continue to progress as they have in the past, more rapidly than armor, will not they, or even new weapons of offense now unknown, cause the use of armor for ships to be abandoned and become obsolete, as the invention of gunpowder drove out of use armor for men? This is a serious question, usually answered in the affirmative by civilians and often by military men, and merits consideration, for if armor is ever to be abandoned, now is the time for us to give it up and plan our new ships on other lines.

Two arguments are commonly advanced in favor of the opinion that armor for ships of war will, in course of time, become obsolete. The first is based upon the supposed analogy of the case of ships with that of men—since the development of small arms resulted in the abandonment of armor for men, why will not continued advance in the power of ordnance render it useless to

armor ships? The answer is simply that the analogy is a false one; the strength of the individual is limited. while the carrying power of ships depends only upon their size and may be made as great as we please. Moreover, a man being far more highly organized than any work of human hands, is put "hors de combat" by a wound in any part of his body, and consequently must be completely covered with armor to be really protected; while a ship, over a very large percentage of her area, may be pierced through and through without suffering serious damage, and needs protection only over a few vital parts. Lastly, even if the power of guns were so great as to render it useless to attempt to keep out their armor-piercing projectiles from any part of a ship, still an enormous advantage would result from the use of armor which kept out explosive shell. A solid bullet is enough if it hits a man, but a great many solid shot of the largest size may pass through a ship without putting her out of action. A distinguished British naval officer in expressing his contempt for all sorts of pounders, from 18's to 68's, when firing solid shot, added, "but, for God's sake, keep out the shells," and his remark expressed the truth, learned from actual experience of war, that the highest and real function of armor is to keep out explosive shell.

The second argument against the continued use of armor for ships is that the approaching advent of the "high explosive shell" will render it worse than useless, the enormous masses of explosive to be hurled against ships by the guns of the future being sufficient to blow in their sides and destroy them without penetration of their armor. Now, that we can, to-day, throw large charges of high explosives from our ordinary guns and detonate them on impact I do not doubt, but what I do doubt and deny is the alleged effect of such detonations. In order to give projectiles sufficient flatness of trajectory to enable us to have any practical chance of hitting an enemy's ship, we must make their walls of considerable thickness to withstand the strains of firing, whether from powder guns or air guns, and the effect of the detonation of high explosives is so local in its character that when such shell strike against armor the result is the complete shattering of the shell with little or no other effect. On the other hand, if we make the shell strong enough to pierce armor, and use delay-action fuses to detonate them, the amount

of the explosive which can be put into the largest shell is too small to do great damage. In fact, as far as the experiments we have thus far made go, powder shell are more destructive than those filled with other explosives, and the idea of blowing in the side of an armored ship by the explosion of a shell is, in my opinion, a fallacious one.

But even allowing that in time to come the best armor will not only be unable to keep out the solid shot of large guns, but also their explosive shell, still a little consideration will show that by keeping out projectiles of the lesser calibres armor will render service of immense value.

Taking, for example, the proposed battery of the new battleships, four 13-inch, four 8-inch, fourteen 5-inch rapid-fire and twenty-six smaller rapid-fire guns, and assuming the turret guns to be in use constantly, while the rapid-fire guns, mounted in broadside, are in use only half the time, and allowing that the rate of fire is once every five minutes for the 13-inch, once every two minutes for the 8-inch, three times a minute for the 5-inch, and four times a minute for the smaller rapid-fire guns, we find, by a simple calculation, that of all the projectiles fired in any period of time only $\frac{6}{10}$ of one per cent. will be of 13-inch calibre, $1\frac{6}{10}$ per cent. of 8-inch calibre, $16\frac{5}{10}$ per cent. of 5-inch calibre, and $81\frac{3}{10}$ per cent. of the smaller calibres. In other words, 3-inch armor will keep out at least $81\frac{3}{10}$ per cent. of all projectiles fired by one battleship against another, 6-inch armor will keep out at least 98 per cent., and 12-inch armor will keep out at least $99\frac{4}{10}$ per cent. When we consider the fact that most impacts will not be normal and that the range will usually be considerable, we may safely say that under any probable future conditions armor of about 7-inch thickness will keep out 98 per cent. of all projectiles fired against it.

Assuming, then, that it is at least probable that armor will continue in use indefinitely on ships of war, let us consider somewhat how it can be distributed to the best advantage.

The displacement, and, consequently, the weight-carrying capacity of ships, being limited by practical considerations of expense and handiness, it is apparent that a defensive covering of even moderate thickness cannot be spread over their entire area, but that it must be limited to those portions of each ship which it is of vital importance to protect. It is of the first importance

to preserve the stability of a ship by preventing such extensive water-line damage as to cause her to sink or capsize. Next in importance is the protection of the propelling machinery. Lastly, the offensive weapons of a ship, her guns, with their machinery and crews, must be as far as possible guarded from injury. With all power of offense destroyed, a ship may be saved, if her stability and propelling machinery are intact; with offensive weapons powerless and machinery disabled, the crew at least will escape destruction, and the fortunes of war may even cause the rescue of the ship herself from the hands of the enemy, provided she continues to float; but a sufficiently effective attack upon the stability of a ship must result in a total loss of ship, crew and all.

I do not mean to imply that floatability is to be absolutely assured first, then safety of the propelling machinery, and, lastly, that of the battery; this is a question of relative protection only. What I mean is, that in distributing our protection we should endeavor to, *first*, make it unlikely that our ship will be sunk in action; *second*, make it unlikely that her motive power will be destroyed; *third*, make it unlikely that her offensive power will be greatly weakened. The bigger the ship, the more unlikely all three should be. As to the prime importance of preserving floatability I think there can be no question, but the relative importance of motive and offensive powers seems somewhat doubtful. A total loss of manœuvring power is extremely unlikely under any circumstances, on account of the subdivision and under-water position of propelling machinery; but so also is the complete silencing of the battery very unlikely. When, however, we consider the fact that in the past ships have always been defeated by the reduction of their offensive powers, due to destruction and demoralization of their personnel, I think it fair to conclude that, although a *moderate* protection of motive power is only second in importance to the protection of stability, yet, after this is assured, then the protection of the guns and their crews becomes the more important. It must not be forgotten that there is an essential difference between the case of a whole ship, with men and machinery distributed throughout its length, and the small turret or casemate into which the vitality of a ship is crowded. "It is the thin line instead of the close column." In the modern battleship, where the offensive power is practically concentrated in *two* gun positions, it is more important to prevent

any projectile from entering these spaces than it is to protect the whole length of the machinery space. If a projectile enters the turret it will probably put out of action, practically, one-half the ship's battery, but many projectiles may enter the machinery space without destroying the motive power. Moreover, the propelling machinery—boilers, engines, shafting, screws and rudder—being almost entirely below the water-line, the armor which is applied to the protection of the stability serves a double purpose, protecting the machinery as well.

Leaving out of consideration the class of so-called protected cruisers, in which an armored deck, flat amidships and sloping off on either side and at both ends below the water-line, affords the sole protection to the machinery, we find in almost universal use in armored ships a heavy armor belt, partially submerged, and of length varying from half that of the vessel to her complete length. This belt is usually composed of tapered plates, the below-water parts thinner than those above, and the plates becoming thinner as bow and stern are approached. When the belt is not complete an armored deck is fitted, sloping down forward and aft from its ends, which are connected by thwartship bulkheads.

The armor protection for the offensive weapons consists of turrets and barbettes, with ammunition supply tubes, and of casemates.

Besides the above, guns in the open are usually fitted with light shields, and the between-decks portions of the smokestacks are sometimes armored.

There being but a limited weight of armor allowable, it is evidently a question of great importance to properly proportion it so that the most advantageous distribution of the protection may result. Yet when we examine the plans of armored vessels built or building in our own and foreign countries, we cannot fail to discover that in many instances this important subject has been given too little consideration. When, for example, we see ships so designed that they will probably go into action with their armor-belts completely submerged; when we see them with heavy armor about the gun supports and with less, or even none, to protect the guns and their crews; and when, the most frequent of all, we see what may aptly be called "fictitious protection," such as thick conning towers which the impact of a heavy projectile would tear from their flimsy fastenings, and heavy armor

plating of so little width that it would yield by being split long before it was pierced, then it becomes apparent that the subject of the proper distribution of armor protection needs discussion.

The following are the principles upon which I believe the armor distribution of battleships should be governed, with the arguments in favor of them.

(1) The *position* of the belt should be fixed with reference to the deep-laden draft of the ship, not her light draft. The practice of placing the belt with three-fifths or two-thirds below water at what is called normal draft is bad, because when a ship goes into action she will probably be laden down with extra ammunition and carry every pound of coal possible. Everything tends to sink your belt lower, and, if too low, you cannot raise it, but if too high you can always sink it to the proper place by letting in water.

The width of belt we have adopted for our battleships is 7′ 6″, and hitherto we have placed the belt so that at what is called "normal," but is really "light" draft, the upper edge is 3′ 0″ above water. Now the Indiana and class, with bunkers full (1640 tons of coal), draw 27′.15, or 3′.15 more than when at so-called normal draft (400 tons of coal). Consequently, if they go into action with bunkers nearly full and no other excess of weights, their belts will be only 1′ above water. But when their turret guns are trained to one side a heel of 3° results, and this will submerge their belts nearly a foot on the engaged side. In the new battleships balanced turrets will be used, and, consequently, there will be no heel due to training the guns; but it is proposed to place the belt 3′ above water at light draft (500 tons), which would put it only 1′ 6″ above with full bunkers (1300 tons). The Bureau of Ordnance wishes to raise the belts 1′, so as to be 2′ 6″ above water at heavy draft. The real questions are: 1st, What is the best position for the belt when the ship goes into action, and, 2d, what will the draft probably be when the ship goes into action? Now it seems to me that to have the belt 2′ 6″ above water and 5′ below is better than 1′ 6″ above and 6′ below, but in any event, having once decided on the best position with reference to the water-line, then we should place the belt so as to be in that position when the ship is *deep*-laden, for she is much more likely to go into action deep-laden than light, and being light she can be sunk deeper by admitting water to her

double-bottom compartments, increasing her stability at the same time; whereas, being deep, she cannot be lightened.

(2) Belt armor should be thick enough to keep out all explosive shell. This will probably require a thickness equal to the calibre of the largest guns brought against it. Over the machinery space it should be of uniform thickness or very slightly tapered. Great taper weakens a plate in greater proportion than the saving of weight. Complete belts are not specially necessary, for the ends of the ship will get few hits compared with the central portion; there is little to protect at the ends, and water-line damage there is of comparatively small importance. The width of the belt should be at least seven times the calibre of the largest gun likely to be brought against it. The new English battleships (Magnificent class) are to have only 9-inch side armor, but I think this hardly sufficient. Our 13-inch common steel shell will carry a bursting charge of 60 pounds through that armor if they hit normally.

(3) The heavy guns should be protected by turrets and their supports by barbettes. The thickness of the turret armor should be greater rather than less than that of the barbettes. Both should be thick enough to keep out explosive shell, but the turret should, if possible, be thick enough to keep out all projectiles. The armor around the guns should be thicker than the side armor, because the turrets are more likely to be hit than the belt, since they always offer themselves to normal impact whatever the enemy's position, while the belt will practically always be at an angle to the line of hostile fire, and since the effect of a projectile which gets into the turret is likely to be far more serious than one which gets through the belt. A solid shot through the side or barbette armor is extremely likely to do no further damage; it will probably put a turret out of action.

The following examples may be cited as illustrating this. At the battle of the Yalu the Itsukushima was struck by a 21 cm. (8-inch) shell, which passed through the coal bunkers containing 30 tons of coal, about 12 feet thick, through a ½-inch bulkhead, and exploded in the engine-room gallery, a space about 15 feet square. Six large fragments passed through the port bulkhead, making holes one foot in diameter, and numerous smaller fragments passed downward into the engine-room, killing one and wounding another man, but doing no other injury. A 6-pounder

shell exploded in the engine-room of the Hashidate without doing any injury. Either of these projectiles exploding in a turret would almost certainly have done serious damage.

(4) Ammunition tubes, or other means of protecting ammunition in transit from magazine to turret, are worse than useless except in the case of the heaviest guns, where any damage to the mechanical hoists would put the guns out of action. Whenever ammunition can be hoisted by whip, a clear passage, with no enclosing walls, is the best. Many of our ships are designed with ammunition hoists enclosed by steel tubes from one inch to two inches thick. A projectile striking one of these tubes would almost certainly bulge it in or distort it so as to completely shut off the supply of ammunition. Whereas, if there were no tube, the projectile could, at worst, cut the whip or other hoisting apparatus, a damage easily repaired, or, as a remote possibility, strike the ammunition in transit, an occurrence not likely to result in any serious consequences.

(5) Heavy conning towers, also, are worse than useless. The impossibility of getting a commanding view from such a station would certainly prevent the captain of a ship from occupying the conning tower in action. I would suggest a moderately thick armor plate, placed fore and aft, and well braced from each side, as a shield, on either side of which the commanding officer might stand. A speaking-tube, with a branch on each side of the shield, and leading to a distributing chamber below, would afford a convenient means of communication to all parts of the ship, the captain's orders being received at the central station and thence transmitted as required. Perhaps an armored well below the bridge would serve even better, orders by word of mouth being there heard and distributed by voice-tubes or telephones.

(6) The secondary battery of 4-inch or 5-inch rapid-fire guns should be in an armored casemate between the main turrets, and should be protected by at least four inches of armor. This thickness will keep out most explosive shell and all projectiles from small rapid-fire guns.

(7) Between the casemate, or armored superstructure, and the thick armor belt is a wide space which it is now usual to protect against explosive shell by the use of 4-inch or 5-inch armor. I have some doubts as to the advisability of this practice. Certainly the Indiana class and the Iowa designs, where four inches

of armor is applied over this space, while the casemate is unprotected except by 4-inch sponsons where the guns are mounted, are not good. Much better would it have been to have used this weight of armor for a complete covering of the superstructure.

In the new battleships where the superstructure has 6 inches of armor all over, it may be very well to cover the space above the heavy belt with 5-inch armor, but I am inclined to think that an addition to the height of the thick belt would be better.

As an example of armor distribution, the following table of weights for the Indiana class and the Iowa may be interesting:

	Indiana.	Iowa.
Protective deck,	534 tons	562 tons
12-inch and 8-inch gun positions,	1556	1440
Side and bulkhead,	1085	1045
Protection to secondary battery,	38	39
Conning tower and tube,	55	56
Cellulose,	55	65
Bolts and backing,	201	168
Total weight for protection,	3524	3375
	3375	
	149 tons difference.	

It is curious to note the difference in these designs, and, from my point of view at least, the sacrifice of real to apparent advantages in the latter design.

The Iowa, with the same coal supply on board, is of 700 tons greater displacement than the Indiana; she carries 149 tons less armor (2 inches less on her barbettes and 4 inches less on her belt), and she has 12-inch guns instead of the 13-inch of the Indiana, and, as a result of these great sacrifices, she can steam one knot faster. In order to add a knot to her speed she is made 700 tons larger and her offensive and defensive powers are greatly reduced. The curious arguments made in favor of the Iowa design were: 1st, "Progress in ordnance had resulted in such an increase of the power of guns that the only moderate calibres were now necessary to overcome any armor," and, 2d,

"The recent developments in armor manufacture had resulted in such an increased power of resistance that it was safe to reduce its thickness." We had succeeded in making our guns so powerful that they were irresistible, and our armor so strong that it could not be overcome.

Fortunately, wiser counsels now prevail and the new battleships are to have 13-inch guns, and, in any event, a better armor distribution than we have had before, though the exact arrangement is still in doubt. The following table gives the approximate distribution of armor weights:

Protective deck,	556 tons
13-inch and 8-inch gun positions,	1600
Side and bulkhead,	1083
Protection to auxiliary battery,	381
Conning tower and tube,	57
Cellulose,	60
Bolts and backing,	235
Total weight of protection,	3982

It will be observed that, practically, all the additional weight of armor, about 400 tons, is to be devoted to the protection of the guns and personnel.

When we consider the armoring of ships smaller than the battleships, another problem presents itself. Only a moderate amount of protection can here be given, and, at the same time, only guns of medium calibre will be found on an enemy of the same class.

On the assumption that such ships will be armed with either six or eight 8-inch guns in turrets, and with a large number of 5-inch rapid-fire guns in broadside, which would be the most effective battery for use against another lightly-armored ship, we have to consider how to protect such a battery, and what the relative importance of the protection of stability, propelling machinery and battery is in such a ship. On the New York and Brooklyn we have devoted almost all our armor weight to a protective deck six inches thick on the slope, a belt four inches thick covering the middle length of the water-line, the 8-inch guns being in turrets of about 6-inch thickness, and the rapid-fire guns having nothing but shields.

This seems to me an unsatisfactory distribution. Would it not be better to trust to the armored deck with cellulose and coal above it for protection both to stability and machinery, and give 4-inch protection to the battery deck? At present, a sufficient number of 6-pounders on an enemy would make the New York or Brooklyn's gun-deck untenable, while their machinery is reasonably safe against the guns of a battleship. An armored cruiser may have to fight a battleship, but her main object is to exceed in power other armored cruisers, and this can only be when her defensive powers are not only proportioned to her offensive, but when they are properly proportioned among themselves.

And now, in conclusion, I wish to say a word about the importance of large calibre in the attack of armor. You may go on increasing velocities and improving projectiles as much as you please, but you can never get the terrible destructive effect of the large shell from a small one. This is so in the case of explosive shell, but it is even more so with armor-piercing shell, which are practically solid shot. The cracking and shattering effect upon the armor plate and the tearing, splintering and rending of the structures behind armor produced by big shell must be seen to be appreciated. There are many advocates of the restriction of calibre of naval guns to 12-inch, or even 10-inch, and you often hear it said, or read in books and papers, that the "best naval opinion" is for keeping down calibre. I beg of you not to believe this. The circumstances of actual fighting at sea add immensely to the effectiveness of armor and reduce greatly the power of guns in comparison with their relative values on the proving ground. The 13-inch gun is necessary for our battleships, and it is a concession to prejudice that restricts calibre to that size. The increase of one inch from 12 inches to 13 inches seems small, but it means an actual increase of energy of one-third, and a sight of the results of firing the 12-inch and 13-inch guns at the same plate would convince any one of the great value of this increase. Happily it has been settled that the new battleships are to have the 13-inch guns and not the 12-inch, and I do not hesitate to predict that if we ever have a naval war with a first-class power we will rather regret not having installed larger guns than the reverse.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE TURRETS OF THE NEW BATTLESHIPS.

By ENSIGN JOSEPH STRAUSS, U. S. Navy.

The armament for the new battleships 5 and 6 has been the subject of so much discussion that it would probably be of interest to the service to give the reasons why the novel arrangement of double turrets has been adopted.

For technical and structural reasons, economy of weight, etc., it has now become the general practice of battleship designers all over the world to arrange the principal guns of the ship, whether they are 10, 12 or 13-inch, in pairs in two turrets or barbettes, one forward and one aft on the centre-line of the vessel. With this arrangement of the principal guns decided upon, the question then arises: How place the guns of lesser size and importance?

Naturally, a commander would manœuvre his vessel to bring all of his principal guns to bear on the enemy, and this result can only be obtained by bringing him to bear on points between the quarter and the bow; that is, generally speaking, on the broadside. He can fire the forward pair ahead or the after pair astern; but only in the arc above stated can his entire principal battery be brought to bear, and it is this fact that induces an arrangement of the subsidiary battery that will give it its greatest importance when the enemy is on the broadside.

The arrangement of battery in the Indiana class followed the recommendation of the Policy Board, and later the Russians laid down the Petropavlosk class, which were almost identical in arrangement with the former. It is unquestionably a heavy battery with good command of fire, but has the one fault of having four 8-inch turrets, but two of which can be fired at the same enemy; two turrets must always mask the other two, and when weight and space are so valuable, any arrangement that will do

away with this wastefulness should certainly receive careful study and consideration.

A reference to Fig. 1, which represents a plan of the Indiana, giving the position of her turrets, will show that she can deliver the fire from four 13-inch guns and four 8-inch guns at a target on the beam. She can fire two 13-inch guns and four 8-inch guns *dead ahead;* but to bring all of the latter guns to bear, the target must not be much off the midship line; for although the 8-inch turrets are arranged to fire 15° across the bow, it is extremely doubtful if the blast from their guns would not seriously injure the people in the 13-inch turret, situated but little below the axis of the 8-inch guns, and then directly in the line of fire.

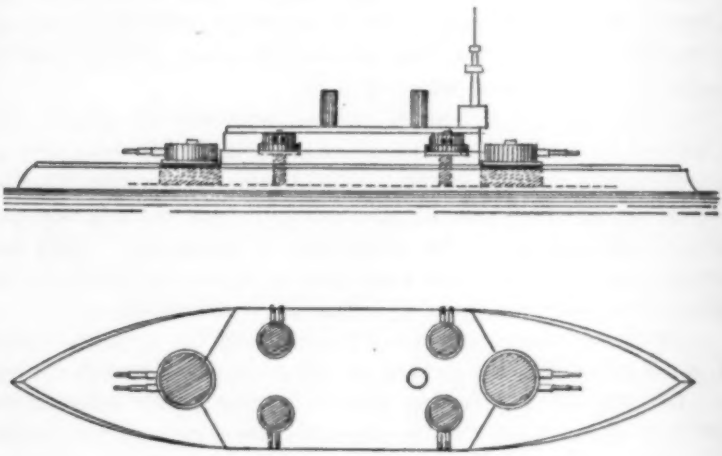

FIG. 1.

It may be said, therefore, that the Indiana's fire consists of four 13-inch guns and four 8-inch guns on the broadside, and (practically) two 13-inch guns and two 8-inch guns ahead, leaving out of consideration in this discussion the minor battery.

Fig. 2 shows an arrangement by which the two superfluous turrets are gotten rid of at once and the weight of fire kept the same; and were it not for certain objections which I shall cite, would be an easy solution of the problem.

1. The main force of the blast from the 8-inch guns comes directly over the 13-inch turret. It has been proposed to obviate this by an inch plate two feet above the roof of the latter. This

plate would have to be so well supported, however, that the view of the men at the sighting-hoods would be seriously interfered with. Experiments at Indian Head have demonstrated this. But, however well it is supported, it no longer affords protection to the men when the 8-inch turret is trained on the bow. The blast-plate is also likely to imprison the smoke from the 8-inch guns and interfere with the view of the men at the 13-inch sighting-hoods.

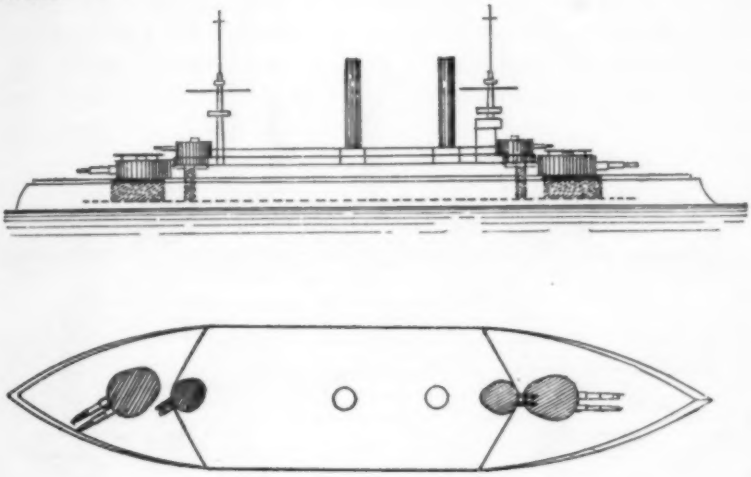

FIG. 2.

2. The area of the superstructure is seriously reduced and the space for boats, hammocks, chests, ventilators, hatches, etc., impaired. The length of the engine-room and fire-room spaces is also very much shortened.

3. The men at the forward two rapid-fire 5-inch guns on each side are subjected to an uncomfortable if not dangerous blast when the 8-inch guns are fired abaft the beam.

Fig. 3 shows a second solution of the problem; that is, of superposing the 8-inch turrets over the 13-inch turrets. It is this plan that has been adopted, and it will be seen at once that none of the objections incident to plan 2 obtain in this case, besides which many additional advantages are gained.

The first objection that naturally occurs to one in considering this plan, is "putting too many eggs in one basket." That is, should the 13-inch turret become jammed, or its rotation other-

wise interfered with, the 8-inch guns of that turret would also become useless. This is true, but it is less the basis for an objection than appears on the face of it; for we have now entirely dispensed with one set of rotating gear, including engines, rollers, roller-paths and turning-tube, and the chance for disablement which otherwise rests on the poorly protected turning gear of the 8-inch turret is now, if not eliminated, transferred to that which obtains with the thoroughly protected turning gear of the 13-inch.

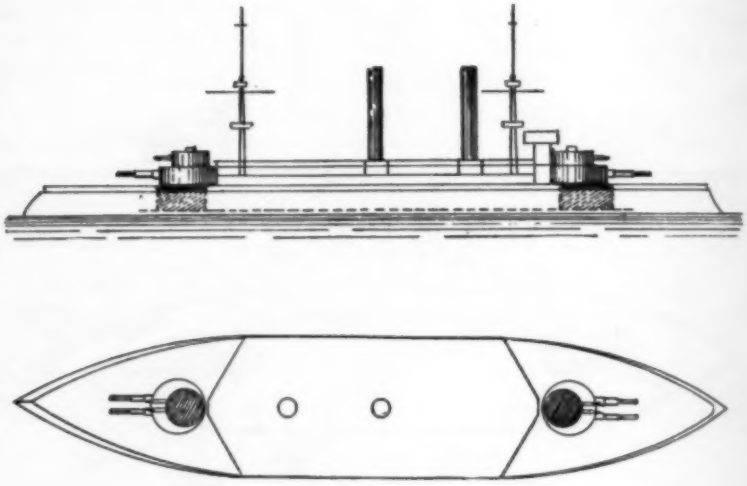

FIG. 3.

The great concentration of weight in the ship is another objection which has been urged. This objection is without foundation. The entire weight of one double turret, including guns, armor, framing, turret equipment, barbette-armor and turning engines, in fact everything that belongs to that part of the battery except the ammunition, will weigh in battleships 5 and 6, 947 tons. The weight of a 13-inch emplacement in the Indiana class exceeds this by 40 tons; and in the British Victoria the weight exceeded even that by at least 200 tons.

Complexity of ammunition supply was thought to be a hindrance to the successful mounting of guns on this plan. A glance as Fig. 4 will show how simply this part of the scheme is carried out. *A* is the handling room for the upper turret, and *B* for the lower turret. Their respective ammunition rooms are situated

just outside of the handling rooms. The car in *B* is loaded with shell and powder charges and in one sweep is carried up by either hydraulic or electric power, with an alternative of hand-power in each case, directly to the rear of the 13-inch gun, and each section rammed home. The entire track rotates with the turret. In the same manner the 8-inch ammunition is hoisted to the rear of the guns in the upper turret, and runs *through* the lower turret, between the big guns, occupying no otherwise useful space in the latter, and, being enclosed in a small chute, its passage in no way interferes with the operations going on in the lower turret. Every gun can be loaded in any position of train, and the operation of each ammunition hoist is as independent as if situated in a separate turret.

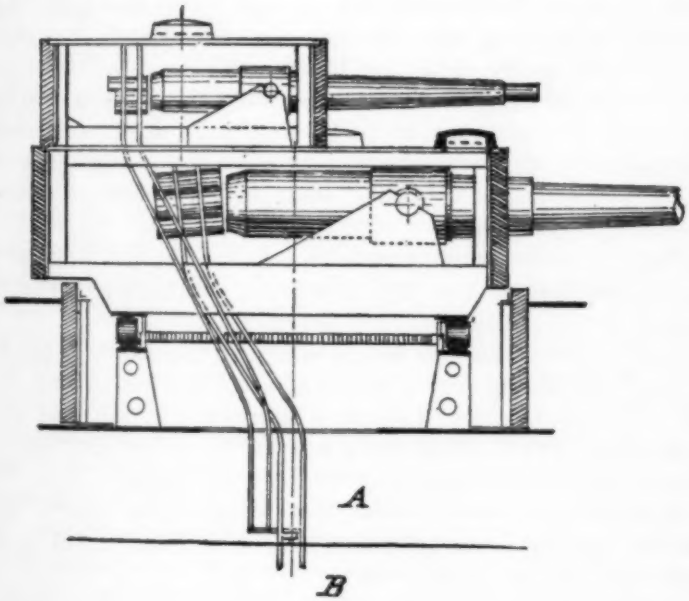

FIG. 4.

There is no communication between the two turrets other than through voice pipes, if that is thought necessary, and the two being separated by a 3-inch armor plate, no fragments from the upper turret can by any possibility lodge in the machinery of the lower and disable it.

The only objection on tactical grounds that has been made

against this system is, that it might be desirable to fire the 8-inch guns at one part of the enemy's ship and the heavier guns at some other part of the vessel where the protection is heavier. This is not an objection when one considers how small a target the largest ship presents when distant any reasonable fighting range. To make the most hits some one point must be chosen to fire at, and this point is undoubtedly the middle of the ship. The heavier shots may occasionally be wasted on thin armor, and the lighter ones strike harmlessly on the heavy belt or turret armor of the opponent; that the opposite result may obtain belongs to the chance of battle, and its probability would be lessened were any attempt made to tell off guns for different duties. At very close range the work of the heaviest guns would be in attacking the belt and turrets; this does not prevent the lighter guns being directed against the casemate, or even trained against the unarmored ends, as the latter can be fired two or three times while the former are being loaded. It takes but thirty seconds to train the turret from starboard to port, and a heavy fire could be maintained against a weak enemy to port while the 13-inch guns were being prepared for delivering their blows against a stronger enemy to starboard.

Turning to the other side of the question, we will find that the advantages arising from this system are much more certain and well defined.

1. We have gotten rid of two complete turrets, their handling rooms, magazines, shell rooms, operating machinery and crews, with little or no loss of effective gun-fire. In the case of the Indiana the weight saved would have amounted to 320 tons.

2. We have dispensed with the barbette armor, turning tube, turning engines and framing for substructure of two more turrets, which saves an additional weight of about 140 tons, making a total saving of 460 tons.

3. The ammunition supply of the two upper turrets is now protected with 15 inches of armor, whereas in the Indiana class the ammunition supply is unprotected. It is almost impossible to adequately protect this important part of the battery, and it must be counted as an immense advantage when this can be made secure without the addition of a pound of weight. In all this saving of weight we are permitted to increase the armor shielding the 8-inch guns, and this in the adopted design has been done.

The turrets are to have 11 inches of armor in front and 9 inches in the rear.

4. Best possible command. The principal battery is reduced to two impregnable gun emplacements. The commander will need only to manœuvre his ship to bring these to bear—a most important consideration when one takes into account the many vital duties devolving on him in the heat of battle. He need not stop to consider whether the fire from one gun is going to injure the crew of another. This latter is a point that has not received the consideration in designing ships here and abroad that it deserves. A glaring example of this fault is found in the French battleship Brennus, where a system of bugle calls has been adopted by which one or more gun's crews must desert their guns and seek cover from the blast of some heavy gun that is about to be fired.

5. More space for secondary battery. This has been touched upon before, and it is only necessary to state that at least four more 5-inch guns can be efficiently mounted than when the turrets are separate.

6. Simplicity. In line with the great simplicity that is accomplished, a concentration of fire may be produced that would be impossible with any other scheme. One man trains four guns, and his sole duty is to keep the target "on" under the direction of the commander. At each gun of the four a man is stationed to look out for the elevation, and when that is attained, the guns may be fired, separately or together.

7. Smaller target. Not only is the vulnerable target area reduced 22 per cent., but concentrating it at two widely separated points provides a distinct advantage—that of removing the main battery from the region of the most hits.

The advantages of the arrangement of battery that has been adopted have been set forth without any attempt to place them in the order of their importance. From one point of view the great saving in weight could be placed first, involving, as it does, decreased draught, or increased coal supply or heavier armament; from the point of view of the captain who is to handle these ships in battle, the absolute control and simplicity are alone a sufficient warrant to depart so radically from former methods.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL MILITIA MOVEMENT.

By Lieutenant A. P. Niblack, U. S. Navy.

Historical and Otherwise.

A brief review of the Naval Militia movement will show how it has grown out of an endeavor to create a national naval reserve of men and ships for war purposes, and how the original intention has been more or less modified in favor of local or State organizations of citizens of aquatic tastes rather than those of the strictly sea-faring class.

Historically, the first step may be said to have been taken by the introduction by Senator Whitthorne of Senate Bill 3320, on February 17th, 1887: "To create a Naval Reserve of auxiliary cruisers, officers, and men from the mercantile marine of the United States." This measure did not become a law, but as a result the Navy Department in 1887 prepared a plan of organization for a Naval Militia force based on a battery of 80 petty officers and men as a unit. On January 4th, 1888, Mr. Whitthorne introduced a bill (H. R. 1847) for which, on June 26th of the same year, he substituted H. R. 10,622, "To provide for the enrollment of a Naval Militia and the organization of naval forces." It made it lawful in States and Territories bordering on the sea and lake coasts or navigable rivers to enroll and designate as the Naval Militia, all sea-faring men of whatever calling or occupation, and all men engaged in the navigation of the rivers, lakes and other waters, all persons engaged in the construction and management of ships and crafts, or any part thereof, upon such waters, together with ship owners and their employés, yacht owners, members of yacht clubs, and all other associations for aquatic pursuits, and all ex-officers and former enlisted men of

the navy. The limits of age were between eighteen and forty-five. The bill contemplated a naval reserve artillery and a naval reserve torpedo corps, the battery to consist of not less than four officers and eighty petty officers and men as the unit of the naval reserve artillery, and the crew to consist of not less than one officer and sixteen petty officers and men as the unit of the naval reserve torpedo corps. This measure did not become a law, but was the basis of State action in several States.

The Legislature of Massachusetts passed an act which was approved May 17th, 1888, establishing "A Naval Battalion to be attached to the Volunteer Militia." This was really the pioneer measure in the United States, but the organization under it was not completed till March 25th, 1890. The State of Pennsylvania, under an act approved April 26th, 1889, made provision for the establishment of not less than four companies "to constitute a Battalion to be known as the Naval Battalion of the National Guard of Pennsylvania." On the same day the Legislature of Rhode Island "established a Naval Battalion to be attached to the Rhode Island Militia." The Legislature of New York passed an act, approved June 14, 1889, to establish a State Naval Militia of three battalions of Naval Reserve Artillery, and a Naval Reserve Torpedo Corps to consist of not less than four companies to a battalion.

In 1890 little was done except in the way of perfecting the organizations in States which had passed laws. The Massachusetts Naval Battalion drilled on board the receiving ship Wabash and the New York Battalion on board the receiving ship Minnesota. The year 1891 was, however, a most important one. On March 2, 1891, Congress appropriated $25,000 for arms and equipments for the Naval Militia, and in June the Department issued regulations governing the disbursement of the fund pro rata, one allotment being paid on July 1st and a reserve allotted on October 1st. On March 31, 1891, an act was approved in California for a naval battalion. The Governor of North Carolina granted permission (September 23d) for the formation of a battalion of naval artillery, to consist of not less than two batteries, as a part of the National Guard. No law was passed directly authorizing the establishment of a naval militia. In the same way the Galveston Artillery Company was ordered by the Governor of Texas enrolled as a "battery for sea-coast defense," and

was recognized by the Department as a naval militia force in Texas.

On October 1st, 1891, the total militia strength was (officers and men) as follows:

California	371
New York	342
Massachusetts	238
North Carolina	101
Rhode Island	54
Texas	43
Total	1149

On August 25, 1891, the oyster police force of Maryland reorganized as a Naval Reserve Battalion of three companies, but it was not recognized by the Department till the next year. Pennsylvania organized as a civic organization in September, 1891, but was not mustered in till the following year.

During July, 1891, the naval battalions of Massachusetts and New York, with the Rhode Island naval militia distributed amongst them as volunteers, were drilled on board the vessels of the Squadron of Evolution under the command of Rear Admiral J. G. Walker, U. S. Navy.

The acts of Congress annually appropriating $25,000 for "arms and equipment" for the Naval Militia leave the disbursement of this sum "under such regulations as the Secretary of the Navy may prescribe." The regulations issued by the Department, August 23, 1892, contained a proviso to the effect that $20,000 should be allotted on October 1st and the remaining $5000 on December 1, 1892, "to be apportioned among those States whose Naval Militia (or a detachment thereof) have actually drilled on board a vessel-of-war for a period of not less than four consecutive days at some time between June 1st and December 1, 1892, to be distributed in the proportion which the detachment so drilled from each State bears to the whole number so drilled from all the States," etc.

During 1892 the legislatures of Maryland, Vermont and South Carolina passed acts relating to the Naval Militia, approved respectively April 7th, November 21st and December 15th. The Lafayette Artillery of Charleston, S. C., and the Beaufort Volunteer

Artillery of the same State transferred to the Naval Militia, and the Galveston Artillery dropped out. On May 18th the Pennsylvania organization made application to the Governor of that State to be enrolled, but owing to the troubles at Homestead, Pa., this was not done till October 29th, too late to share in the annual appropriation for that year.

The returns of officers and men for October, 1892, were as follows:

Rhode Island	58
Maryland	124
South Carolina	208
North Carolina	296
Massachusetts	331
California	376
New York	401
Total	1794

During the summer of 1892 the Naval Militia organizations were drilled as follows:

Forty officers and men of the North Carolina Naval Militia paid their own expenses to Norfolk, Va., there being no appropriation by the State, and were quartered on the Franklin from June 13th to 18th and drilled on board the Newark. The Massachusetts Naval Militia were drilled on board of the Wabash, Chicago and Atlanta from July 5th to 9th, and the New York divisions on board the New Hampshire, Chicago and Atlanta, July 11th to 23d. The California Naval Militia drilled at various times in August and early in October on board the Charleston.

In 1893 the following States passed laws relating to the Naval Militia, which were approved on the dates named: North Carolina, March 6; Michigan, May 31; Illinois, June 21; Connecticut, July 1; and Georgia, December 19. In the regulations of the Department governing the distribution of the annual appropriation for 1893, "only uniformed petty officers and enlisted men" were hereafter to be considered in making the apportionment, one-half of the allotment due any State to be withheld until the Governor shall inform the Department officially "that a proper naval uniform has been adopted and issued to its Naval Militia." Notice was also given that all arms and equipment issued by the

Department should remain the property of the United States, and should be receipted for and annually accounted for on blank forms furnished by the Department.

By a joint resolution of Congress, approved November 3, 1893, the model battle-ship Illinois at the World's Columbian Exposition at Chicago was transferred to the State of Illinois as a naval armory for the use of the Naval Militia of that State.

The annual return of the strength of the Naval Militia (petty officers and enlisted men) in the various States for 1893 was as follows:

Massachusetts	589
Rhode Island	119
New York	410
Pennsylvania	150
Maryland	130
North Carolina	262
South Carolina	204
California	301
Illinois	211
Total	2376

During the summer of 1893 the following facilities were afforded the Naval Militia for drill and instruction on naval vessels: The Naval Militia of Massachusetts were embarked on the San Francisco and Miantonomoh from July 18th to 21st, a sufficient number of their regular crews having been temporarily transferred to the Wabash to make room for them. The Bristol Division of the Rhode Island Naval Militia were embarked on board the Miantonomoh for four days' drill. A part of the Philadelphia divisions of the Pennsylvania Naval Militia and the two separate Rochester divisions of the New York Naval Militia received four days' instruction at sea on the flagship San Francisco, a sufficient number of the regular crew of the ship being transferred to the Vermont to make room for them. The 1st battalion of the New York Naval Militia spent a week on board of the old line-of-battle ship New Hampshire at anchor in Cold Spring Harbor, Long Island. The North Carolina Naval Militia received four days' instruction in drill and target practice on the Kearsarge. After their tour of duty the monitor Nantucket was

turned over to the Governor of North Carolina for the use of the Naval Militia of that State. Owing to a disastrous storm on the coast the Naval Militia of South Carolina did not go to sea on the Kearsarge as intended, and owing to the fact that no man-of-war was available on the Pacific Coast the Naval Militia of California did not get a cruise.

In 1894 New Jersey and Virginia passed laws authorizing the formation of Naval Militia battalions, and Michigan and Connecticut organized divisions at Detroit and New Haven respectively. A bill was introduced in Congress authorizing the formation of a battalion in the District of Columbia, but it did not become a law. An act was passed by Congress and approved August 3, 1894, authorizing and empowering the Secretary of the Navy to loan temporarily to any State vessels of the Navy "not suitable or required for general service, together with such of her apparel, charts, books and instruments of navigation as he may deem proper, said vessel to be used only by the regularly organized Naval Militia of the State for the purposes of drill and instruction."

The annual return of petty officers and enlisted men in the Naval Militia organizations of the various States for 1894 was as follows:

Massachusetts	448
North Carolina	168
Rhode Island	113
South Carolina	208
Connecticut	65
California	320
New York	432
Illinois	367
Pennsylvania	217
Michigan	73
Maryland	128
Total	2539

During the summer of 1894 the Naval Militia organizations received instruction on board naval vessels as follows: Massachusetts encamped her brigade on Lovell's Island, Boston Harbor. During the encampment the monitor Passaic was loaned to this

State, and drills and target practice were had on board the Miantonomoh and Atlanta. The two divisions of Rhode Island drilled on board the Miantonomoh. Connecticut's force received instruction on the Atlanta in Long Island Sound. New York's battalion and the two separate divisions from Rochester spent a week on board the New York and San Francisco in Gardiner's Bay, Long Island. The Pennsylvania contingent from Philadelphia and Pittsburg were embarked on the New York and incidentally had target practice at sea. The Montgomery co-operated with the Nantucket at Smithport, N. C., in instructing the battalion of North Carolina. Maryland and South Carolina did not avail themselves of an offer to embark for instruction. No ship was available for the forces of California, Illinois or Michigan.

Suggestions as to Organization.

In most of the States the naval militia laws and regulations are practically those of the general military code of the State with a few additional sections or chapters devoted to their peculiar needs. For this reason it is impossible to more than suggest a few leading features which will tend to make the organizations more uniform.

Provision should be made for the performance of the annual tour of duty outside of the limits of the State whenever in the judgment of the commander-in-chief of the State forces it shall be expedient to do so, especially where a scheme of joint instruction shall be proposed by the Navy Department at some important strategic point in an adjacent State.

The rank and designation of commissioned and petty officers of the naval militia should be the same as the corresponding ranks in the navy. The commissioned officers should be designated in the law, but the number and rank of petty officers should be such as the commander-in-chief of the State forces may from time to time prescribe. This will enable changes to be made to correspond with any new or changed ratings in the navy without the necessity for appealing to the legislature from time to time to amend the law.

The pay should be the same as that of commissioned officers, petty officers, and seamen of the navy of corresponding grades or classes. Where four days of the annual tour of duty shall be

spent in boat reconnoissance work or cruising, or where one or more vessels of the navy shall co-operate with the organization during said period for purposes of instruction, the duty shall count as "sea duty," and the pay shall be "sea pay" for the tour. Where the organization is called out by the State for local purposes in time of riot or domestic violence, or for other causes, the duty shall be regarded as "shore or other duty," unless performed afloat, and the pay shall be "shore pay."

What are known as "companies" in infantry or "batteries" in artillery should, in the naval militia organizations, be designated as divisions. From two to four divisions should constitute a battalion, and from two to four battalions a brigade, designated as a naval brigade. The naval battalions should be treated as battalions, and not as part of a regiment of the national guard or land militia of the State. The maximum number of petty officers and men in a division should be one hundred. The minimum may vary in each State according to discretion, but a certain group unit should be recognized. Sixteen men and one petty officer is the minimum subdivision or group unit. This is a boat's crew, a section of artillery (field), a torpedo crew, or an engineer's section. It will also be a unit or multiple in the new infantry tactics. To each division there may therefore be attached groups of the artificer or special classes as additional to the small divisions in some of the States. The number and ratings of the petty officers should be regulated, as before stated, from State headquarters.

The officers of the naval brigade should consist of a captain as chief of brigade, and a staff consisting of one commander as chief of staff and executive officer; one lieutenant as brigade adjutant and chief navigating officer; one lieutenant as chief signal, ordnance and equipment officer; one paymaster, one surgeon, and one chief engineer of the relative rank of lieutenant; one ensign as signal officer, and one ensign as aide to chief of brigade. These officers should be chosen and commissioned as soon as two battalions are completely organized.

Where the maximum organization allowed in a State by law is a battalion, the commanding officer should be a commander and the executive officer a lieutenant-commander. To each battalion in a brigade organization, however, there should be one lieutenant-commander to command the same; and a staff officer to

consist of one lieutenant as battalion adjutant and executive officer, one lieutenant as navigating, ordnance and equipment officer, one ensign as signal officer and assistant to navigating, ordnance and equipment officer; one surgeon and one paymaster of the relative rank of lieutenant (junior grade), and one assistant surgeon of the relative rank of ensign. To each division there should be one lieutenant to command the same, one lieutenant (junior grade), and one ensign. Each separate part of a battalion not in the same county of the State as the battalion headquarters should have one assistant surgeon of the relative rank of ensign, and one additional ensign for each division.

A very good regulation obtains in Connecticut by which seamen are divided into three classes, 1st, 2d, and 3d, although the pay is the same. The power to rate or disrate should be lodged with the commanding officer, to thus give him power to discipline or reward men, and to discriminate between recruits and those who have served some time and are efficient.

The necessary outfit to completely equip a brigade, battalion, or division of the naval militia is outlined in the annual report for this year.

The uniform of both officers and men should be of a naval pattern, but the State coat-of-arms should be worn in conjunction with rank devices.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Charles E. Munroe.

No. XXVI.

Through the courtesy of Col. Majendie we are in receipt of the *18th Ann. Report of H. M. Insp. Exp., 1893,* which, like their former reports, is replete with interesting and valuable information. It is impossible, with so voluminous a report, to do more than briefly allude to but a few of the interesting facts presented, and we note, first, that the importations of dynamite for 1893 are 90 per cent., of gelatine dynamite 9 per cent., and of matagnite gelatine 68 per cent. less than for 1892, while that of detonators is increased, over 7,179,000 having been brought in. In the required tests of explosives imported and sold, all the dynamite samples were very satisfactory, but of the plastic explosives the same cannot be said, as 33 per cent. of the blasting gelatine and 23 per cent. of the gelignite samples failed.

The danger from accidents with frozen plastic explosives, especially while thawing them, is dwelt upon at length, the admirable instructions of the Nobel's Explosive Company on this matter being given in detail, and it is stated by the latter that blasting gelatine may become congealed at temperatures as high as 45° F. without altering the soft and plastic outward appearance of the cartridges. In his report, Dr. Dupré says that while only three out of 78 samples of gelatinized preparations failed to pass the heat test, a far larger number came very near the limit,

*As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars. *Address, Columbian University, Washington, D. C.*

and he again urges that both the nitroglycerin and nitro-cotton used in these preparations be purified to such a degree as to stand the heat test for a longer time than that required officially for each by itself. Mr. Hake, inspector of explosives in Australia, calls attention to the fact that certain grades of gelatine dynamite containing wood meal suffer considerably, as regards stability, during their passage from England, and the spontaneous explosion of over 17,000 pounds of blasting gelatine at Matoonga, Bombay, December 28, 1891, shows that their continued stability is not yet assured. Taking the facts of this accident with that at Aden in 1888, and probably certain others in India, it would appear that the destructive change in the explosive in such a climate is effected in three to four years.

Among the many accidents recorded is a very detailed and non-sensational account of the frightful explosion at Santander, Spain, November 3, 1893, from which it appears that about 33 tons of dynamite were exploded, 510 persons were killed and about 2000 wounded. A singular case was that of the explosion of about one ounce of nitroglycerin in the converter at Perranpath, Cornwall, September 5, 1893, due, it is believed, to the acids and nitroglycerin retained by the scale and rust accumulated in the bottom of the converter. The explosion of ecrasite in the laboratory of the Austrian War Office, August 1, 1893, while a projectile was being filled with it, is of especial interest to ordnance officers, though unfortunately no details are given. The accident at Waltham Abbey, March 2, 1893, was a remarkable one, since 4212 pounds of gun-cotton in the drying stove caught fire and burnt up without exploding, though 308 pounds at Ardeer, on October 27, 1882, under somewhat similar circumstances, produced a violent explosion.

The fire at Tangye's safety-fuze factory, August 10, 1893, furnished some interesting results, in that 144,000 feet (nearly 28 (?) miles) of "tube safety-fuze," containing one and one-half ounces of gunpowder to every twenty-four feet, were consumed without any explosion whatever.

The new explosives examined were westfalite, a mixture of ammonium nitrate and gum lac, Von Förster's powder, a pure nitro-cellulose thoroughly gelatinized and mixed with a little chalk, and Schnebelite, a powder containing a small percentage of potassium chlorate.

Through the courtesy of Dr. T. M. Chatard we are in receipt of a copy of his address as president of the Chemical Society of Washington, entitled "The Abuse of Explosives, with Suggestions for Preventive Laws."*

After describing the properties and methods of manufacture of the characteristic explosive substances, Dr. Chatard says:

All explosives, in their nature and mode of production, can be divided into a few classes; the processes of manufacture are in principle very simple; and all sorts of mixtures can be made which are easily exploded. Under such conditions it is evident that prevention of their vicious use is surrounded with peculiar difficulties in addition to those which are always met with in attempting to control the sale or use of articles for which there is a legitimate general demand.

Granting the necessity of legislation to prevent abuse of explosives, we may lay down the general principle that it cannot be made effective if it interferes unduly with legitimate manufacture and employment.

In all engineering work, high explosives, when used, are not luxuries, but necessities. Not only can work be done more cheaply by their aid, but often could not be done without them. Examples might be given, but it is perfectly well known that this necessity is absolute, and that the great development of the explosive business has been caused by the demand of the engineer. He requires that his explosives shall be safe to transport, store, and handle, certain and powerful in action, and that the combustion shall be complete, leaving no deleterious residues. To satisfy these requirements the manufacturer must employ all the resources of skill, and only well-managed works can produce reliable articles in an economical manner.

It is not believed that the abuse of explosives can be prevented by governmental inspection or supervision of manufacture, transportation, or even sale. The laws of France are most minute on these points, but do not prevent outrages. Legal regulation may and can protect the workmen, the inhabitants of a neighborhood, the transportation agents, or the traveling public. For excise purposes, supervision of sale may be necessary, but cannot prevent crime. Explosives purchased from legal dealers and strictly according to provisions of law may be unlawfully used; they may

* Bulletin No. 8, Chem. Soc., Washington, Gibson Bros., 1893.

be stolen from lawful possessors by intending evil-doers, or the latter can easily obtain the materials for making their own explosives. Nitric acid, an essential, has such extended uses that it can be bought at any druggist's. Nor is it necessary to purchase the acid, as it can be easily made by distilling a mixture of nitrate of soda and sulphuric acid, both of which are in common use among farmers for composts and other home-made fertilizers. It is also very likely that in most cases of carefully planned outrages the explosives would, in part at least, be made by the conspirators.

But although governmental supervision of manufacture, storage, transportation, sale and use cannot be relied upon to prevent the vicious use of explosives, still this supervision would be an important aid. Moreover, such supervisional control, if acting under acceptable regulations, can be made very beneficial to this industry, and would be welcomed by most of those immediately interested. Col. Majendie, in a most interesting and valuable report on the operation of the laws affecting the manufacture and handling of gunpowder, shows that the English powder-makers, far from objecting to a rigid system of control, were glad to record themselves in favor of it, if it were made reasonable and general, and then rigorously enforced.

The reason for this is plain. Arrangements for the protection of the works, the workmen, and the neighborhood cost money, both to introduce and to maintain. If one manufacturer endeavors to protect his works or workmen by special improvements, care and regulations, he will not be able to produce as cheaply as his competitors if the latter are permitted to work without restriction. The same thing is true in the case of transportation agencies and dealers. The former often find it necessary to make regulations governing the transportation of explosives, and should always be aided by the law in enforcing them.

Such regulations when made by private individuals or corporations are always difficult to enforce. Even when clearly made for their own protection, workmen often stubbornly resist them and try to evade them in every way, nor is it easy to punish disobedience when detected. Nor is the general public much superior in this respect. The cry of tyranny is raised, and the demagogue, in his glory, vehemently denounces these encroachments on freedom.

If this supervision is desirable, the law should be national and general, passed by Congress and enforced by the General Government. State laws, however good, stop at the State line, and the best intentions of local legislators are often paralyzed by representations that their action will "drive away business," "lose votes," or any other of the cant phrases. The present condition of the oyster industry in Maryland is an instructive lesson, for there a small minority of people, who being well intentioned but ignorant of their true interests, have successfully resisted every attempt to prevent them from killing their goose, to the damage of the interests of the entire State. The law should provide a certain *minimum* of regulation—should be a minimum law.

Before attempting to frame such a law, a careful investigation and study of the practical requirements should be made by a commission appointed for the purpose. It should be made clear to all those interested—manufacturers, railroad men, dealers, engineers, miners, quarrymen and other workers—that their opinions, advice and criticism are sought for and are welcomed; that no legislation will be recommended until its provisions and their practical effect have been thoroughly discussed and substantially agreed to by them; and that no more legislation will be attempted than that which they themselves consider as the minimum amount necessary for the general welfare and protection. Intelligent newspaper discussion will be especially valuable, for it will clarify the public mind and detect deficiencies and defects which might otherwise escape notice until a time when their discovery might inflict serious injury on the whole matter.

Having thus investigated the subject, the commission can present to Congress its conclusions in the form of a general law providing for this minimum amount of control. As this law will have been already thoroughly discussed, understood and approved, the final sanction should be easily obtained. A law thus carefully framed should need but little machinery for its enforcement. Regulations suitable and acceptable to each branch of the business can, in the light of the previous investigations, be easily made under its provisions, and when officially promulgated would be binding on all. Methods of procedure against offenders should be simple, direct and summary.

Any serious attempt to prevent the vicious use of explosives will, however, compel us to go further, but in the same direction.

We must have a national and general license law, under which the *simple, unlicensed possession* of any explosive, except those especially excluded, shall be punishable. The excluded explosives should be fireworks and ordinary gunpowder, either loose or in cartridges. Fireworks are sufficiently well looked after by local authority, and any attempt to interfere, in this manner, with the use of gunpowder will result in failure. We must not attempt the impossible; what is possible will be hard enough to attain. The wording of the licenses will have to be varied to suit the circumstances; but, in fact, but few forms will be necessary. They should be obtainable at the least possible cost, with the least possible inconvenience; and the granting of them should not be discretionary, but be under rules clearly laid down. Discretionary action in this connection is wholly unnecessary and would be injurious.

How such a law would work in practice will best be shown by considering some particular cases. A chemist desires to carry on an investigation in explosives. He personally presents his written application, giving whatever information the general regulations may require, and receives his license. This entitles him and his assistants under his direction to do whatever work he may desire within the limits of his laboratory, but does not permit him or any one else to carry his explosives outside of those limits, or even to take them to some other place for further experimentation. For this purpose another form of license, equally easily obtainable, should be required. These restrictions interfere in no way with his scientific or practical work, but do aid in protecting the public.

Now let us consider the mining industry. If the license system will work well in that branch of engineering, it ought to in any other. A new mine is to be opened, and somebody is put in charge of the work. When it becomes necessary for him to procure explosives he goes to the nearest licensing office, files an application, which, again, is made out according to a prescribed form, and on payment of a very small fee receives an appropriate license. This license confers upon the licensee the right to store and use explosives upon the mining property, the name, location and limits of which are sufficiently nearly described in the license. Outside of those limits the license is entirely void. Included, but in express terms, is the permission to purchase explosives of any

kind or in any quantity, whenever and wherever the licensee may desire, and to convey the same to the property, either from the dealers direct or from the most conveniently situated public transportation point. The license should be personal and non-transferable, should run for not more than one year from date, and then *absolutely* expire. Renewal, if desired, should be an entirely new transaction, which can occur during the life of the first license, which must, of course, be simultaneously surrendered and destroyed. There would be no increase of restrictions on the purchase of explosives in consequence of this license law. The dealer should not be required to know that the purchaser is licensed. If any sale restrictions are introduced, these should come through the operation of the general code of dealers' regulations, framed for their protection, as previously indicated.

In the same way the transportation agents need only require that the packages of explosives are properly prepared for shipment, according to their own special code. Their responsibility would be the same as at present and would cease with the delivery of the goods. As to the conveyance of the explosives from the dealer's store or the railway station to the mine, this should be covered by the license. Some regulation for wagon transportation may be necessary, but otherwise no special liability should attach to the teamster during *bona fide* transit.

The explosives having reached the mine, are issued to the miners for use. This use is covered by the license to the superintendent, who may, as at present, make whatever rules for its conduct he may deem advisable. Certain regulations, however, should be made obligatory by law. In some cases the miners are furnished with explosives at the expense of the mine; in others they buy them from the management as they do their oil, candles, etc. If, at the end of his shift, a miner has any surplus explosive, he must deposit this in an appropriate place, provided by the company, where he can get it at the beginning of his next shift. Whether he has purchased it or not should make no variation in this regulation. Under no circumstances should he be permitted to take explosives to his dwelling-place, even if this be within the limits of the mining property. His family and neighbors must be protected. As to carrying it outside of those limits, both superintendent and miners stand on an equal footing. Both are absolutely forbidden to do so. If work is to be done

on a neighboring property, another license must be obtained for this. If the general magazine is situated on the first property, the new license can permit conveyance from one place to the other.

There is no occasion for licensing the individual miners, nor should this ever be done. There should be but one license for any one place, and that should be issued to the superintendent alone. Only through his permission can any one, within the limits of the property, legally have possession of any explosive.

With some changes in language the mining license will serve for the needs of the farmer, who sometimes finds it advantageous to use high explosives for the removal of stumps and rocks, and for other purposes—within the limits of his farm he may use them; outside of it, not at all. A special form of license covering a certain district, say a county license, will be necessary for well-diggers and others whose work is in the form of jobs of indefinite duration and location. The same may be said of prospectors, whose mode of life and manner of work present peculiar difficulties in the way of control.

Having in this manner provided for the needs of all legitimate business, we can then insist that the unlicensed possession of explosives shall be punishable, without reference to the intentions of the transgressor. The law of the District of Columbia concerning concealed weapons is an example. A man may be arrested for some trifling offense, but it is found that he has upon his person a concealed weapon. He makes no attempt to use it, but he has it. When he is brought up for trial he may even be acquitted of the offense, but is fined $50 or punished by an equivalent imprisonment for having the weapon. His intentions are not considered; the fact is sufficient for condemnation, and there is no appeal. Of course the previous arrest has nothing to do with this, except as having given the opportunity to ascertain the fact.

Some such summary proceeding will be necessary under the license law if this is to be effective. Inasmuch as there will be no reason for unlicensed possession, the proof of fact will be sufficient. As the licenses are local and limited, the chances of detection of illicit actions will be greatly increased, as the real licensees and the nature of their licenses will be generally known. Moreover, any licensee transgressing the limitations of his license becomes at once amenable to a punishment, which some of his neighbors at least will see to it that he gets. In offenses against

this law, evil intentions should be presumed. If their absence can be satisfactorily proven, then the punishment can be reduced to a minimum; but there should always be a punishment, which for many reasons should be an imprisonment, with or without a fine, but need not be heavy or severe.

Dynamite outrages are generally planned and the explosives procured some time in advance. The power of summary arrest for possession conferred by this law would much increase the chances of prevention, for it would only be necessary for some secret information as to this possession to reach the proper authorities to enable them instantly to arrest the offending parties. The finding of the explosive would be quite sufficient for condemnation without the necessity of exposing the informer. During the resulting imprisonment further investigation could be made, but one such arrest would probably prevent the execution of the plan by the others concerned. Again, if the penalty for simple possession be not made too severe, the probability of obtaining such secret information will be much greater. As the laws are at present, should any one of a group of conspirators be seized with remorse and desire to prevent an intended outrage, he can only do so effectively by betraying the criminal intentions of his fellows. He knows that if he does this he will probably be compelled to give public testimony upon which may depend the lives of others who have trusted him and who are probably no more guilty than he. Moreover, through this publicity not only must he undergo all the obloquy which society, while availing itself of his services, heaps upon the informer, but also expose himself to private vengeance. This he may well hesitate to do; but if such a man knew that by merely revealing the fact of possession the outrage could be prevented without exposing any one of his fellows to any greater punishment than that attaching to illegal possession, it is reasonable to suppose that useful pre-repentance would be more frequent. It is prevention, not punishment, that is to be sought for.

The power of summary action and arrest for possession is indispensable. The authorities should be empowered to act at once upon information, and no other warrant for search or arrest should be required. Secrecy and suddenness of action will have a far more paralyzing effect upon the dynamiter than any display of the majesty of the law, which it is his purpose and study to defy and make contemptible. To those who may object that such proceed-

ings would be too high-handed, unconstitutional, etc., it may be replied that it is time that some of the technicalities that have been carefully built up around our laws should be swept away and justice be less impeded. It is time that some change should be made in the principle that law-abiding people must wait until the vicious perform overt acts before any legal steps can be taken to restrain them, and that then these steps, to be legal, must be according to rules apparently framed to give the greatest amount of trouble and expense to the prosecutor and the greatest chance of escape to the offender.

We do not need very severe laws to check dynamite outrages. A law which is plain, just and simple—under which detection will be easy and punishment certain—will require no heavy penalties to make it effective, so far as mere unlawful possession is concerned, but any attempts to make a criminal use of explosives—any threats, verbal or written, to do so—any incitements, verbal or written, of others to make such use against anybody in particular or society in general, or an expressed approval of such actions, should meet with speedy and severe punishment, which no legal technicalities should be permitted to delay. Such things are done and said to disturb and terrify the public, and usually by persons to whom the certainty of close confinement at hard labor will act as an effective deterrent. The Johann Mosts, O'Donovan Rossas and Louise Michels of society would speedily find their occupations and themselves gone to the penitentiary, where their usefulness to the world would be much increased. Of course those who are entrusted with the execution of such a law must be especially watchful lest its purpose be perverted to a means for private revenge or persecution. These may occur in any branch of criminal law, but must always be suspected and looked for in this connection, since secret information must be so much depended upon. If their existence is proved, the offenders should be most heavily punished, and none of the technicalities impeding convictions for perjury in ordinary cases should be permitted to have any force here.

It has been said that the licenses should specify the use. This should be broadly considered. What is meant is that such misuses as killing fish with dynamite, explosions for amusement, etc., shall be absolutely prohibited, license or no license. They are either barbarous or wholly unnecessary.

The excluded explosives are fireworks and gunpowder. All desirable amusement and noise can be obtained by their use. It is true that quite as disastrous outrages can be perpetrated by the aid of gunpowder as by that of dynamite, but its employment has not such a terrifying effect upon the public, who are accustomed to its use, which they could not be deprived of even if this were desirable. The recent introduction of smokeless powders for sporting purposes brings in, however, new complications. These powders are from two to four times as powerful as ordinary gunpowder, and are quite as effective for outrages as any of the dynamite preparations. How far their use should be controlled would be a matter for special consideration, but a license ought to be required for their possession. Convenient as they are, they are not necessary either for sport or protection. The great hunters, such as Gordon-Cumming, had not even breech-loaders; the old flint-lock served our purpose at Bunker Hill and Bennington, and was more than we wanted at Bladensburg; while if any son of the Revolution, American or otherwise, will load up his ancestor's horse-pistols and shoot as straight as we hope the old man did, his burglar will be as completely *hors de combat* as if he had been operated on by the latest improvement in firearms.

In 1894 Senator Hawley introduced into the Sundry Civil Bill H. R. 5575, 53d Congress, second session, the following clause: "To enable the Secretary of the Treasury to investigate and report upon the importation, use, transportation and manufacture of high and low explosives, with the view of securing by legislation greater security to life and property, five thousand dollars."

Acting on this, the Secretary of the Treasury appointed Mr. West Steever, a lawyer of the District of Columbia, who, on January 1, 1895, rendered a preliminary report which appears as Ex. Doc. No. 181, 53d Congress, third session. Mr. Steever says:

"This preliminary report will be confined to the first of the four branches in which the proposed investigation was prescribed by Congress to be conducted, viz. the importation of high and low explosives from foreign countries into the United States. Owing to the fact that until of recent date the importation of explosives from foreign countries into the United States has been of an insignificant character, very little attention has been paid

by Congress to regulate or restrict their introduction into this country.

"The only legislation on the statute book relating to the subject of the importation of high explosives from foreign countries into the United States is the act of Congress approved July 3, 1866 (Stat. at L., Vol. xiv, p. 81), and forming sections 5353, 5354 and 5355, under the title of Crimes, and sections 4278, 4279 and 4280, under the title of Commerce and Navigation, of the Revised Statutes of the United States.

"Section 5353 is a 'qui tam' action, and prescribes, among other provisions, for the importation in passenger conveyances of certain high explosives which have long since been discarded for more modern discoveries and consequently may be considered absolutely as a dead letter. No conviction has ever been reported in the books under this section, and an indictment under it for the importation of the recently discovered explosives would certainly be quashed by any court before which it would be brought.

"Section 5354 makes the offense, in addition to the 'qui tam' feature as above, manslaughter, with term of imprisonment for a period of not less than two years. This law, for the same reason, would even be still more difficult to enforce, for the obvious objection that it would involve a criminal conviction for the importation of high explosives totally unknown when the act of Congress was passed, and which are the only explosives now known to commerce.

"Section 5355 prescribed a 'qui tam' action if these long since discarded explosives are not packed in metallic vessels surrounded by plaster of paris and marked 'Nitroglycerin, dangerous.'

"It is hardly worth while discussing this section, as the described explosives no longer form a part of commerce, and modern science has found that there is no more dangerous mode of packing any high explosive than placing the same in metallic vessels, as prescribed in this section. As Berthelot declares that no explosive more powerful has yet been discovered than nitroglycerin (not combined with any other substance), and as it freezes at 12° (say 54° F.), it can easily be conceived how dangerous it would be to transport this explosive in the mode prescribed in this section. The exuding of nitroglycerin was sup-

posed to be the only cause of its being subject to premature explosion, and the plaster of paris surrounding the receptacle was supposed to render it innocuous, but this idea has long since been discarded. The great danger is undoubtedly by its liability to freeze, and in this state it will explode even without any perceptible cause to the human sense.

"Sections 4278 and 4279 declare that it shall not be lawful to transport the said explosives between any foreign country to a place in any State, Territory, or District of the United States, and between any place in one State, Territory, or District of the United States and a place in any other State, Territory, or District of the United States, or any passenger-vehicle, or any vessel or vehicle of any description upon land or water, except packed in a metallic vessel surrounded by plaster of paris, and marked 'Nitroglycerin, dangerous.' These sections are obsolete for the reasons already adduced, as explained in commenting on the criminal and 'qui tam' sections above.

"At the time of the passage of the above-mentioned act of Congress very little was known definitely in regard to the composition or action of high explosives. It is true that Nobel had discovered dynamite a few months previous, but the manufacture has not been so perfected as to make it an article of commerce, and I am satisfied that no court would entertain for a moment such a strain of the language used as would bring any of the modern explosives within the purview of the penal sanctions of the statute.

"It is now nearly thirty years since Nobel made this great discovery, which proved to be the first practical step in the development of the manufacture of high explosives. During that period changes amounting almost to a revolution in the art of war have occurred by its use, and its influence in the peaceful avocations of life has not been of less importance. We are, though, but on the threshold, and there is every probability of even still greater changes in the near future. The great problem heretofore existing is to find some means to control the pressure generated by a high explosive, while eliminating what is technically called its 'work.' It is claimed that this has been recently accomplished in England, and an engine in the form of a ram for pile driving has been constructed, in which explosive power is used instead of steam, and, though still crude in principle, the work for which it is used is done with surprising energy and is

far superior to the relative steam engine used for the same purpose.

"Section 4280 is a proviso that none of the preceding sections shall be so construed as to prevent any State, Territory, District, city, or town within the United States from regulating or prohibiting the traffic or transportation of those substances within their said limits, or from prohibiting their introduction within said territorial limits for sale, use, or consumption therein.

"In the case of Bowman *v.* Chicago and Northwestern Railway Company, these sections of the Revised Statutes were discussed by the Supreme Court of the United States. Mr. Justice Matthews delivered the opinion of the court in the following language (125 U. S., 484):

> **But sections 4278 and 4279 relate also to the transportation of nitroglycerin and other similar explosive substances by land or water, and either as a matter of commerce with foreign countries or among the several States. Section 4280 provides that the two preceding sections shall not be so construed as to prevent any 'State, Territory, district, city, or town within the United States from regulating or from prohibiting the traffic in or transportation of those substances between persons or places lying or being within their territorial limits, or from prohibiting the introduction thereof into such limits for sale, use, or consumption therein.' So far as these regulations made by Congress extend they are certainly indications of its intention that the transportation of commodities between the States shall be free, except where it is positively restricted by Congress itself or by the States in particular cases by the express permission of Congress.**

"I would beg, also, to state that in my investigation of the laws of the different civilized nations in regard to regulating the importation of explosives, all such laws are framed so as not to interfere with the local laws and ordinances in force at the time of the promulgation of the general law. It stands to reason that no general law can regulate the subject without taking into consideration such local laws and ordinances suitable to the different localities for which they are enacted. As much activity in effecting general legislation on this subject has been displayed in the past twenty years in Europe, I beg to submit an epitome of the laws of the leading nations which have more particularly regulated the importation of explosives within their limits, and which is hereunto appended and marked A.

"I regard the enactment of a law regulating the importation from foreign countries into the United States of both high and

low explosives as the first step toward 'securing by legislation greater security to life and property.' Perhaps no commerce between nations is so fluctuating as that of explosives. Statistics show that one year may differ entirely from another, both in quantity and kind, and this is governed by the variety of demand and supply created by new discoveries and inventions, subject to all the contingencies of human life in peace and war and which cannot possibly be foreseen by the home manufacturer. The past year is a fair index, as in the early part the importation into this country was confined almost entirely to the ingredient nitrates and glycerin, but latterly a large amount of high explosives have arrived on our shores.

"Taking these views into consideration, I would beg to submit, to be embodied into legislation in part or the whole, a bill 'to regulate the importation of gunpowder, nitroglycerin and other explosive substances,' which is herewith attached and marked Appendix B.

"The classifications in this bill have been made as closely as possible to those prevailing in Europe, due regard being paid to the recent discoveries and inventions. The picrate division is, perhaps, the greatest departure, and that has been caused by recent developments in the manufacture of that kind of explosive in France and other countries. The mode of packing is that which is insisted upon in Great Britain, and which has been adopted more or less, or recommended to be adopted, all over the Continent. As the classifications include only the foreign explosives, the packing of such does not affect that prevailing in the United States or imported packages after breaking bulk. I have purposely abstained from introducing in this bill the 'qui tam' features which prevail in our legislation, as no other civilized nation has adopted such in its regulations of the importation of explosives so far as I can discover after diligent search. While the bill creates no new offices, ample means are provided for elasticity in its enforcement in giving discretionary power to the Secretary of the Treasury to grant permits waiving compliance with the stricter regulations contained therein in case of war or like necessity.

"I am satisfied that if the provision of the proposed bill herewith recommended had been a law, or some other legislation of like character had been in existence at the time, that the dynamite

fiend, Alexander Keith (alias William King Thomas, alias William King Thomson, alias George S. Thomas, alias Garne) could never have perpetrated the diabolical crimes with which he has been credited. By shipping explosives from European ports to New York, and then having the same sent back for re-exportation on steamers on which he over-insured goods, he was enabled to hoodwink the police authorities of the eventual ports of departure, and it was only by an appalling accident at Bremerhaven, on the 11th of December, 1875, that his plan of wholesale murder was unearthed. A chest, which had previously made the voyage to New York and returned, and conjectured to contain about 1000 pounds of lithofracteur, while being shipped on board the Mosel is supposed to have slipped out of the hands of the carriers and then falling to the ground exploded with terrible effect. Over one hundred persons were killed and many others more or less injured. A hole 30 feet in circumference and 8 feet in depth was made in the solid stone pavement and soil beneath the quay, and parts of the decks of the Mosel and Simoon tugboat, lying alongside, were carried up in the air and thrown to considerable distances. Everything which presented any resistance was destroyed within 2500 feet. Considerable light damage was done within 10 miles, and the report of the explosion was distinctly heard at a distance of 55 miles from Bremerhaven.

"The author of all this destruction of life and property committed suicide, but confessed before his death that the case was furnished with a clockwork apparatus which was intended to be wound up at Southampton (England) and which, after eight days, would operate to cause the explosion. A quicker trip than usual at this time of the year or a breakdown, causing delay in the clockwork apparatus, might have transferred the scene of explosion to New York harbor instead of Bremerhaven, with still greater destruction of life and property. It is supposed that several steamers that never were heard from were sent to the bottom by this fiend in human shape and by means of like contrivance. It was discovered that his business connections were with leading bankers and manufacturers, and but for the Bremerhaven accident he might have continued his career of crime for an indefinite period of time. After the revelation made through the confession of this ingenious enemy of the human race, it was high time for the civilized nations of the world to take measures

to protect life and property from the machinations of such depraved scoundrels. In this international legislation the United States has lagged behind, I am convinced, not from want of sympathy in the objects to be effected by such legislation, but, owing to our system of dual government, rather from a morbid feeling of dislike to appear to interfere within the sphere of the jurisdiction of the sovereignty of the different States composing the Federal Union.

"I would beg also to call your attention to a still more recent catastrophe caused in great part by lack of needful legislation." The writer here describes the Santander explosion, an account of which is given earlier in these notes from the report of H. M. Inspector of Explosives. He then remarks regarding the accident:

"A glance over the provisions of the legislation as recommended herein will show that an accident inflicting such extensive damage would be impossible to occur at any port of the United States, owing to the restriction of 50,000 pounds to a single cargo imported, as prescribed by the proposed enactment.

"I could add to the above other accidents, almost countless in number, which have occurred from the want of regulations in regard to the importation of explosives and which have forced the civilized nations of the earth into the line of legislation recommended herein, but such relation would be of superfluous weight in argument, as no opposition is anticipated from any quarter. The cost of ocean freight has steadily declined since the regulations as to packing explosives have been understood and enforced by the leading commercial nations of Europe. Before these regulations and restrictions became law, few vessels would accept any cases of explosives as part of their cargo, and, consequently, the rates of freight on such articles were absurdly high, but such regulations and restrictions being enforced by fines and imprisonment, gave confidence to the carrier, and the supply of tonnage soon was equal to the demand. Great difficulty also was found with the insurance companies, which refused to take risks either on the vessels or their cargoes where explosives were carried. Now, though no difficulty is found in placing risks, the rates of ocean insurance are as moderate as on any other merchandise.

"There are a number of railroad companies in the United States that refuse to transport high explosives under any circum-

stances, but upon what grounds they could justify the exclusion of such high explosives from being imported under the regulations of the legislation proposed it would be difficult to imagine. European railway companies have found it to their interest not to pursue so shortsighted a policy, as in case of exclusion the articles are carried surreptitiously concealed with other merchandise, thereby making the danger of premature explosion all the greater. Metal cylinders made to represent oil cans, the cylinders being so constructed with an inner longitudinal partition that a portion amounting to one-tenth of each cylinder was able to and actually did contain oil, while the remaining nine-tenths of the cylinder contained an explosive, was one ingenious method among many others practiced for deceit in transportation. Another almost equally as ingenious was to disguise the high explosive 'tonite' as wine and have it transported as such. In a number of instances parties have been apprehended carrying high explosives on passenger cars in carpetbags or valises and in trunks or chests checked to their destination in baggage cars. In every case the excuse for such wanton recklessness was the prohibition of the railroad company to allow the transportation of such high explosives as freight.

"It was recently asserted as an argument urged for the purpose of obtaining a reduction in the rates of freight asked on explosives, that since the regulations and restrictions by law went into effect in 1875 not a life has been lost by a premature explosion on the railways of Great Britain and Ireland, and the sum of twenty-five dollars (£5) would cover all the damage done to property on such railways up to date. It has been asserted by the railroad companies that they are not responsible for damages in cases of premature explosion if they prohibit the transportation of the explosive, but that they would be liable if transported under regulations of apparent safety but prematurely exploded. After a careful search through the authorities I can find no decision to bear out such an interpretation of the law as existing in this country. This perverted view of the law of damages was used recently in argument in a decision reached by the board of directors by one of our great systems of railroads. Although the officers were all convinced of the safety of the explosive and were willing to transport it, the board of directors decided by an overwhelming vote to continue the suicidal policy of prohibiting the transportation of any and all explosives over their lines.

"As no less than seven kinds of explosives, including detonators, are used in some mines, each being found specially adapted for different work, it can be easily perceived how such action paralyzes the development of that branch of industry in the territory, not including many others, depending for transportation on their system of railroads."

The report is accompanied by two appendixes. Appendix A contains abstracts of the legislation of Austria, France, Germany, Great Britain and Ireland, Norway and Sweden.

Appendix B is a draft of a proposed "bill to regulate the importation of gunpowder, nitroglycerin and other explosive substances," and which is as follows:

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:* That it shall be unlawful to import into the United States any gunpowder, nitroglycerin, dynamite, gun-cotton, blasting powder, fulminate of mercury, fog signals, fireworks, fuzes, rockets, percussion caps, detonators, cartridges, ammunition of all descriptions and every adaptation or preparation of an explosive to produce effect by explosion or a pyrotechnic effect, except in accordance with the regulations prescribed by this act.

"Sec. 2. For the purpose of this act explosives shall be divided into the following seven classes: Class 1, gunpowder; class 2, nitrate mixture; class 3, nitro-compound; class 4, chlorate mixture; class 5, fulminate; class 6, ammunition; and class 7, fireworks.

"Class 1 includes brown, cocoa, lightning, mammoth, olive, orange, pebble, prism, and all those gunpowders of the ordinary black kind, which are used to discharge cannons, mortars, and muskets.

"Class 2 means any preparation other than gunpowder, ordinarily so called, formed by the mechanical mixture of nitrate with any form of carbon or with any carbonaceous substance not possessed of explosive properties, whether sulphur be or be not added to such preparation, and whether such preparation be or be not mechanically mixed with any other non-explosive substance, and includes amide, cahne, carbozotine, diorexin, perulite, haloxyline, heraklin, johnite, oriental, fortis, grenadine, pudrolithe, pyrolithe, pyrononce, pyronitrine, saxifragine, triumph, safety, xanthine, and all other preparations coming within the above definition.

"Class 3 means any chemical compound possessed of explosive properties, or capable of combining with metals to form an explosive compound, which is produced by the chemical action of nitric acid (whether mixed or not with sulphuric acid), or of a nitrate mixed with sulphuric acid, upon any carbonaceous substance, whether such compound is mechanically mixed with any other substances or not. This class shall have three divisions:

"Division 1 comprises such explosives as colonia, dahmanite, diaspon, dualine, dynamite No. 1, dynamite No. 2, dynamagnite, forcite, fulmi-

natine, gelatine dynamite, gelignite, glonoius, glukodine, glyoxiline, lignose, lithofracteur, matagnite, mataziette, meganite, nitroglycerin, nitrolite, orissite, paleine, petralithe, porifera, rendrock, rhesite, sebastine, scranine, vigorite, virite, westfalite, and any chemical compound or mechanically mixed preparation which consists either wholly or partly of nitroglycerin or some other liquid nitro-compound.

"Division 2 shall comprise such explosives as bellite, carbonite, cellulosa, di-fiamyr, emilite, glycero-pyroxiline, kinetite, nitromidine, nitasons, nitroline, nitromaanite, petrofracteur, piera, potentite, pyroxiline, roburite, romit, securite, titan, tonite, xyloglodine, xyloidine, and any nitro-compound, except picrates, not comprised in the first division.

"Division 3 will include the explosives known as bronolithe, emmonite, honitite, lithstite, melinite, oxonite, punshon, victorite, and all other chemical compounds in which picric acid is used as a nitro-substitute.

"Class 4 includes such explosives as asphaline, callow, dynamogen, etnite, inline, pyronnome, rock-a-rock, silesite, schneibelite, viel, and any chemical mixture containing a chlorate.

"Class 5 comprises all fulminates used for percussion caps or any other appliances for developing detonation.

"Class 6 includes any explosive used as ammunition when inclosed in any case or contrivance or otherwise adapted or prepared so as to form a cartridge or charge for small arms, cannon, or other weapon, or for blasting, or to form any tube for firing explosives, or to form any safety or other fuse for blasting or for shells, or to form a percussion cap, a detonator, a fog signal, a shell, a torpedo, a war rocket, or other contrivance other than a firework. This class shall have three divisions:

"Division 1 embraces safety cartridges, safety fuzes, for blasting, railroad fog signals and percussion caps.

"Division 2 comprises any ammunition which does not contain its own means of ignition, such as cartridges for small arms, which are not safety cartridges, cartridges for cannon, shells, mines, blasting or other like purposes, shells and torpedoes containing any explosives, fuzes for blasting which are not safety fuzes, fuzes for shells, tubes for firing explosives and war rockets.

"Division 3 will comprise any ammunition which contains its own means of ignition and is not included in Division 1, such as detonators, cartridges which are not safety cartridges, fuzes for blasting which are not safety fuzes, fuzes for shells, and tubes for firing explosives.

"Class 7 will include all fireworks, and is divided into two divisions:

"Division 1 comprises any firework composition containing any chemical compound which is used for the purpose of making fireworks, and is not included in the former classes of explosives.

"Division 2 includes all manufactured fireworks such as squibs, crackers, serpents, rockets (other than a war rocket), maroon, star, wheel, chinese fire, roman candle, or other article adapted for the production of pyrotechnic effects or signals.

"Sec. 3. No explosive shall be imported into the United States except by virtue of an importation license granted by the Secretary of the

Treasury, and the unloading and delivery, or the transhipping of any explosive shall be included within the provisions of this section.

"Sec. 4. The Secretary of the Treasury may grant an importation license for any such explosive, and may annex thereto any prohibitions and restrictions with respect to the composition and quality of the explosive and the unloading, landing, delivery, and conveyance thereof and such further restrictions as he may think fit for the protection of life and property.

"Sec. 5. The license shall be of such duration as the Secretary of the Treasury may fix, not to exceed six calendar months, and shall be available only for the person or persons named in the license. It shall contain the provision that it may be revoked by the Secretary of the Treasury at any time.

"Sec. 6. The owner and driver of any vehicle, the owner or master of any ship or boat, and the railroad company or conductor of any railroad car on which any explosive is imported into the United States shall not permit the same to be unloaded and delivered to any person who does not hold a license to import the same from the Secretary of the Treasury.

"Sec. 7. No vehicle or wagon on which explosives are imported into the United States shall contain more than 4000 pounds, including weight of enveloping package, and shall not be transported at a faster gait than a walk. It shall carry a black flag, in dimension at least 3 feet square, displayed so as to be of easy view. An extra man to the driver shall accompany such vehicle or wagon, whose duty it shall be to keep off and warn all persons who are smoking from approaching such vehicle or wagon. If moving in trains, each vehicle in such wagon train shall preserve an interval of at least 75 feet from the preceding vehicle.

"Sec. 8. All ships or boats conveying explosives to be imported into the United States shall carry flags of at least 3 feet square, to be displayed at masthead in the former and at the stern in the latter, black in color when on those plying in fresh water and red for all seagoing vessels, and no ship or boat shall carry more than 50,000 pounds weight of explosives.

"Sec. 9. No railroad car on which explosives are imported into the United States shall carry more than 10,000 pounds, including weight of enveloping package, and the number shall be limited to five, allowed to be attached to any freight train. There shall be at least three empty cars, or cars filled with non-combustible merchandise, preceding or following any such cars loaded with explosives. No explosives shall be imported into the United States on any gondola or open car.

"Sec. 10. In the event of any breach by any act of default of the provisions of the preceding sections, with respect to the importation of an explosive, or of the provisions of any importation license, all or any part of the explosive with respect to which such breach is committed, or being in any vehicle, wagon, ship, boat, or railroad car in connection with which such breach is committed, may be forfeited.

"Sec. 11. The gunpowder of class 1, if to be imported into the United States for private use and not for sale, and in safety cartridges, to the amount of 5 pounds for each passenger, shall not be subject to the restriction imposed by this act.

"If imported for sale and not exceeding 5 pounds, it shall be contained in a substantial case, bag, canister, or other receptacle, made and closed so as to prevent the gunpowder from escaping. If exceeding 5 pounds in amount, it shall be contained either in a single package or a double package. A single package shall be a box, barrel, or case of such strength, construction, and character that it will not be broken or accidentally opened, or become defective or insecure while being conveyed, and will not allow the gunpowder to escape. If it is packed in a double package, the inner package shall be a substantial case, bag, canister, or other receptacle made and closed so as to prevent the gunpowder from escaping, and the outer package shall be a box, barrel, or case of wood or metal, or other solid material, and shall be of such strength, construction, and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow the gunpowder to escape. The interior of every package shall be, whether single or double, free from grit and otherwise clean, and every such package, when actually used for the package of gunpowder, shall not be used for any other purpose. There shall not be any iron or steel in the construction of any such package, unless the same is effectually covered with tin, zinc, or other material. The amount of such gunpowder in any single package, or, if there is a double package, in any one outer package, shall not exceed 100 pounds, and on the outermost package there shall be affixed the word "Gunpowder" in conspicuous characters by means of a brand or securely attached label or other mark.

"Sec. 12. The explosives of class 2 (nitrate mixture) if not exceeding 5 pounds in amount shall be contained in a substantial case, bag, canister, or other receptacle made and closed so as to prevent any explosive from escaping. If exceeding 5 pounds in amount, it shall be contained in a double package, the inner package being a substantial case, bag, canister, or other receptacle, made and closed so as to prevent any explosive from escaping, and the outer package shall be a box, barrel, or case of wood or metal, or other solid material, and shall be of such strength, construction, and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape; and the amount of explosive in any one outer package shall not exceed 100 pounds. The interior of every one such package shall be free from grit and otherwise clean, and every package when actually used for the packing of one nitrate mixture shall not be used for the packing of any other nitrate mixture or for any other purpose. There shall not be any iron or steel in the construction of any package unless the same is effectually covered with tin, zinc, or other material, and on the outermost package there shall be affixed in conspicuous characters, by means of a

brand or securely attached label or other mark, the word "Explosive," with the name of the explosive, followed by the word "Nitrate mixture," and the name and address of the sender.

"Sec. 13. The explosives of class 3 (nitro compounds), if not exceeding 5 pounds in amount, shall be contained in a substantial case, bag, canister, or other receptacle made and closed so as to prevent any explosive from escaping. An explosive of the division 1 of this class, if exceeding 5 pounds in amount, shall be contained in a double package, the inner package being a substantial case, bag, or covering without any metal in the construction thereof, and so made and closed as to prevent any explosive from escaping; and any one of such packages shall not contain more than 10 pounds, and the outer package shall be a box, barrel, or case of wood or other solid material (other than metal), and shall be of such strength, construction, and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape. The inner or outer package or both shall be thoroughly waterproof, and the amount of explosive in any one outer package shall not exceed 50 pounds. An explosive of division 2 of this class, if exceeding 5 pounds in amount, shall be contained in a double package. The inner package being a substantial case, bag, canister, or other receptacle made and closed so as to prevent any explosive from escaping; and the outer package shall be a box, barrel, or case of wood or metal, or other solid material, and shall be of such strength, construction, and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape; and the amount of explosive in any one outer package shall not exceed 50 pounds.

"An explosive of division 3, if exceeding 5 pounds, shall be contained in a double package, the inner package being a substantial case, bag, canister, or other receptacle made and closed so as to prevent such explosive from escaping; and the outer package shall be a box, barrel, or case of wood or metal or other solid material, and shall be of such strength, construction and character that it shall not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape; and the amount of explosive in any one outer package shall not exceed 100 pounds. Whatever be the amount of the explosive and to whatever division it belong, the interior of every package shall be free from grit and otherwise clean, and every package when actually used for the packing of one nitro compound shall not be used for the packing of any other nitro compound or for any other purpose, and there shall be no iron or steel in the construction of any inner or outer package unless the same is effectually covered with tin, zinc, or other material. On the outermost package there shall be affixed in conspicuous characters, by means of a brand or securely attached label, or other mark, the word "Explosive," with the name of the explosive followed by the words "Nitro compound," "Division" "1," "2," or "3," as the case may be, and the name and address of the sender.

"Sec. 14. Explosives of class 4 (chlorate mixture), if not exceeding 5 pounds in amount, shall be contained in a substantial bag, case, canister, or other receptacle made and closed so as to prevent any explosive from escaping. If exceeding 5 pounds it shall be contained in a double package. The inner package shall be a substantial case, bag, or covering without any metal in the construction thereof, and so made and closed as to prevent any explosive from escaping, and any one of such packages shall not contain more than 10 pounds; and the outer package shall be a box, barrel, or a case of wood or other solid material (other than metal), and shall be of such strength, construction and character that it will not be broken or accidentally opened, or become defective, or insecure whilst being conveyed and will not allow any explosive to escape, and the amount of explosive in any one outer package shall not exceed 50 pounds. In addition, in the case of an explosive of division 1 of this class, the inner or outer package or both shall be thoroughly waterproof. The interior of every package shall be free from grit and otherwise clean, and every package when actually used for the packing of one chlorate mixture shall not be used for the packing of any other chlorate mixture, or for any other purpose, and there shall not be any iron or steel used in the construction of any outer package unless the same is effectually covered with tin, zinc, or other material. On the outermost package there shall be affixed in conspicuous characters by means of a brand, or securely attached label, or other mark, the word "Explosive," with the name of the explosive followed by the words "Chlorate mixture compound, division 1" (or 2, as the case may be), and the name and address of the sender.

"Sec. 15. Explosives of class 5 (fulminates) which are of such character that they cannot be packed mixed with water, or that danger would arise from such mode of packing, shall be packed in such manner as shall be specially directed by the Secretary of the Treasury. Any other explosive of this class shall be packed in bags or coverings of calico, canvas, or other material permeable to water, and containing each not more than 25 pounds, and so made and closed as to prevent any explosive from escaping. Such bags or coverings shall be packed in a case containing sufficient water to insure the explosive being kept constantly wet, and such inner case shall be packed in an outer case containing sufficient water constantly to surround the inner case, and both cases shall be of such strength, construction and character that neither will be broken nor accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any fulminate or water to escape, and the amount of explosive in any outer case shall not exceed 200 pounds. Every package when actually used for the packing of one fulminate shall not be used for the packing of any other fulminate or for any other purposes, and on the outer case there shall be affixed in conspicuous characters, by means of a brand or securely attached label, or other mark, the word "Explosive," with the name of the explosive followed by the words "Fulminate, division 1" (or 2, as the case may be), and the name and address of the sender.

"Sec. 16. Any explosive of divisions 1 and 2 of class 6 (ammunition) shall be contained in a box, barrel, or case of wood, metal, or other solid material, and of such strength, construction and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape, and any one such package shall not contain more than 100 pounds of such ammunition. Any explosive of division 3 of this class shall be packed in a double package. The inner package shall be a substantial case, bag, canister, or other covering made and closed so as to prevent any explosive from escaping, and shall not contain more than 2 pounds of such explosive. The outer package shall be a box, barrel, or case of wood, metal, or other solid material, and shall be of such strength, construction and character that it will not be broken or accidentally opened or become defective or insecure whilst being conveyed, and will not allow any explosive to escape, and any one such outer package shall not contain more than 50 pounds. The interior of every package, whether single or double, shall be free from grit and otherwise clean.

"Every package, whether single or double, when actually used for the packing of one description of ammunition shall not be used for the packing of any other description of ammunition, or for any purpose, provided that with explosives of division 1 of this class there may be packed any article which is not of an inflammable or explosive character, or liable to cause fire or explosion. On the outermost package there shall be affixed in conspicuous characters, by means of a brand or securely attached label or other mark, in the case of percussion caps or safety fuzes for blasting, the words "percussion caps," or "safety fuzes for blasting," as the case may be, with the name and address of the sender, and in the case of any other ammunition the word "explosive," with the name of the explosive, followed by the words, "ammunition, division 1" (or 2 or 3, as the case may be), and the name of the sender; also indicate if cartridges and charges for cannon, shells, mines, blasting, or other like purpose; the name of the explosive material contained in such cartridge or charge shall be given as "explosive blasting cartridge containing dynamite ammunition, division 2."

"Sec. 17. An explosive of division 1 of class 7 (fireworks) shall be contained in a double package. The inner package shall be a substantial canister case, or other receptacle, hermetically closed, and contain no more than 1 pound of explosive, and the outer package shall be a box, barrel, or case of wood, metal, or other solid material, and shall be of such strength, construction and character that it will not be broken or accidentally opened, or become defective or insecure whilst being conveyed, and will not allow any explosive to escape; and any outer package shall not contain more than 20 pounds, and there shall not be any iron or steel used in the construction of any such inner or outer package unless the same is effectually covered with tin, zinc, or other material. An explosive of division 2 of this class exceeding 5 pounds

in weight shall be contained in a box, barrel, or case of wood, metal, or other solid material, and of such strength, construction and character that it will not be broken or accidentally opened, or become defective and insecure whilst being conveyed, and will not allow any explosive to escape, and the amount of explosive in any one package shall not exceed 100 pounds. The interior of every package, whether single or double, shall be free from grit and otherwise clean, and when such package shall be used for the packing of fireworks shall not be used for any other purpose, and on the outermost package there shall be affixed, in conspicuous characters, by means of a brand or securely attached label, or other mark, the word "Explosive," and the name of the explosive followed by the words "Fireworks, division 1" (or 2, as the case may be), and the name and address of the sender.

"Sec. 18. The Secretary of the Treasury shall have the power to increase the amount of the maximum weight of any explosive allowed to be contained in any one package imported into the United States as prescribed by the act, such increase of weight to be specified in the body of the importation license granted and to be limited to one shipment and during the period of six months ensuing from the date of such license.

"Sec. 19. All officers of the customs shall have the same power with respect to any explosive imported, and the vehicle, car, ship, or boat containing the same, as they have for the time being with respect to any article on the importation of which restrictions are for the time being imposed by the statutes of the United States relating to such importation, and the vehicle, car, boat, or ship containing the same, and the statutes for the time being in force relating to such importation for any such article, or any vehicle, car, ship, or boat shall apply accordingly.

"Sec. 20. The importation from any foreign country into the United States on any railway car of nitroglycerin, or any fulminate, except the fulminate of mercury, is prohibited, and any person who knowingly ships or attempts to ship the same on any such railway car, for such purpose, shall be deemed guilty of a misdemeanor and punished by fine not exceeding $2000, or imprisonment not exceeding eighteen months, and the articles to be liable to seizure and forfeiture.

"Sec. 21. Every person who forges or counterfeits any license granted or required in pursuance or for the purpose of this act, or willfully makes use of any such forged, counterfeit, or false license, shall be liable to imprisonment for a term not exceeding two years.

"Sec. 22. Nothing in this act shall render liable to any penalty or forfeiture the owner or master of any ship or boat or carrier, or the person having charge of any carriage, for any act done in behalf of this act, if he proves that by reason of stress of weather, inevitable accident, or other emergency, the doing of such act was, under the circumstances, necessary and proper.

"Sec. 23. In the event of any breach by any act or default of the provisions with respect to the importation of an explosive, or of the pro-

visions of any importation license, the owner or master of such ship or boat, and the licensee or person to whom the license is delivered shall each be liable to a penalty not exceeding $500, and to a further penalty not exceeding 50 cents for every pound of such explosive.

"Sec. 24. Where a carrier or owner or master of a ship or boat, on which an explosive is imported from any foreign country into the United States, is prevented from complying with the provisions contained in the preceding sections, by the willful act, neglect, or default of the consignor or consignee of the explosive, or other person, or by the improper refusal of the consignee or other person to accept delivery of the explosive, such consignor, consignee, or other person who is guilty of such willful act, neglect, default, or refusal shall be liable to the same penalty to which the carrier, owner, or master is liable for such breach, and his conviction shall exempt the carrier, owner, or master from any penalty or forfeiture whatsoever.

"Sec. 25. Where a court before whom a person is convicted of any offense in breach of the regulations set forth in the preceding sections has power to forfeit any explosive imported from any foreign country into the United States, owned by or found in the possession or under the control of such person, the court may, if it think it just and expedient, in lieu of forfeiting such explosive, impose upon such person, in addition to any other penalty or punishment, a penalty not exceeding such sum as appears to the court to be the value of the explosive so liable to be forfeited.

"Sec. 26. That all laws or parts of laws inconsistent with any of the provisions of this act be, and the same are hereby, repealed."

This recommendation has been embodied in H. R. 8483, of the 53d Congress, third session, introduced by Mr. Wheeler of Alabama.

"Operations of the Division of Military Engineering of the International Congress at Chicago," *Ex. Doc. No. 119*, 53d Congress, second session, 1894, which is a stout volume of about 1000 pages, liberally illustrated, contains an article entitled "Explosives" by W. R. Quinan (pages 429-441), which is an excellent, though too brief, a review of the progress in the explosive art in the United States during the past thirty years, both from the industrial and military standpoint. It will be very wise for those using Guttmann's book, reviewed below, to supplement it with Quinan's article if they wish to know how widely the American departs from the European practice.

Under the title "The Development of Explosives during the Last Quarter Century" (pages 451-457), Lieutenant Willoughby Walke gives "a brief resumé of the recent development of explo-

sives and the underlying principles upon which their manufacture is based," which, while entertaining, contains nothing new either in statement or treatment.

Under the title "The Applications of Explosive Substances," *The Polytechnic*, **10**, 125-133; 1894, publishes an address delivered by Prof. Charles E. Munroe before the Rensselaer Polytechnic Institute of Troy, N. Y., in which the manifold uses of these bodies in the arts and industries, as well as in war, are set forth and described in a popular manner.

Dr. Edwin Pynchon, under the title "High Explosives as a Means of Propulsion in Aerial Navigation," describes in *Transportation*, **3**, 17-21; 1894, with the aid of a considerable number of cuts, a novel air-ship which he has invented and which depends on the explosion of dynamite for its source of energy.

Speaking of this feature of his invention, he says: "The most important part of the whole device is the mechanism for using high explosives. From the magazine room, which is well forward, there extend rearwards two solid oval or grooved pipes of about one inch calibre, each terminating by passing through the upper edge of a concave detonating plate, preferably made of some copper alloy, which plates are placed one at either side of the stern of the vessel, exterior thereto and near the horizontal center of the ship's weight. Properly prepared cartridges are to be automatically fed to these pipes at suitable intervals by a mechanism similar to that of a magazine gun. The cartridges when delivered into the pipes are to be shot by pneumatic pressure to the outer opening at the rear of the vessel and then exploded in the concavity of the detonating plates by aid of the electric current. It will probably be found that the best results will be attained by having the explosion take place near the center of the detonating plate and but a few inches therefrom. The maximum push will thus be secured by the slight air cushion thus provided.

"In order to secure the natural expansive or explosive effects of dynamite, it has heretofore been detonated by the use of a blasting cap, which is first exploded by electricity, or a fuze, and which, by its explosion, generates both the intense heat and concussion required for the detonation of the high explosive. Considerable heat, or the spark of the electric current, when applied to loose

dynamite, which is exposed in the open air, will cause it to ignite and burn, though it is not thus exploded, but 'if, when ignited, it be enclosed in a hermetically sealed vessel with resisting walls, it explodes under the influence of heating' (Berthelot). This is owing to the increase in temperature produced by the retention of the first gases of combustion. Dynamite is also exploded when suddenly heated to a sufficiently high temperature, which is found to be about 420° F. From the above data it is easy to see how dynamite or nitrogelatin may be perfectly exploded without the use of the dangerous fulminate blasting cap. The only requirements would be to first have the explosive encased in a suitable and strong shell or container, and second, to have passing through such cartridge, and imbedded in the explosive, a few strands of fine iron wire which would be heated to a point of incandescence by an electric current of sufficient voltage, say 20 v.

"In using such air-ship, after some degree of ascent and forward motion has been made by use of propeller wheels, a pair of cartridges of low power are caused to detonate. These cartridges are to be fed to their respective tubes, and by a moderate force of compressed air slowly shot through the same. When both cartridges are in proper position for firing a weak electric current is closed, which thereby automatically throws a switch and allows passage through the cartridges of a sufficiently strong current of electricity to fire the same. At the start, when the speed of the ship is moderate, light charges should be used, and said charges increased gradually in size or strength until the maximum speed of the vessel is attained, which may then be maintained by using the maximum charge with such frequency as practice teaches to be best, and which would be more frequent when adverse winds are being encountered than when going with a favorable breeze. As in my suggested plan the propelling power is changed from the forward end of the ship to its stern whenever change is made from use of propeller wheels to use of explosive accelerator, and as it is known that the center of weight should not be far from the center of power, it will probably be found desirable to provide for a certain per cent. of freight or fuel ballast being moved from the middle of the ship toward its stern when such change of powder is being made. In fact, movable ballast will undoubtedly be found of great utility in balancing the ship at all times, no matter what style of propeller is being used.

"In aerial travel the great desideratum is ceaseless and rapid onward motion, and at an altitude of from 500 to 2000 feet the best results should be attained. It is quite probable that a speed of 150 to 200 miles an hour can be easily had, and will, in fact, be necessary in order to insure a commercial success. I have estimated, that with a ship of the size mentioned, after a full speed of 200 miles an hour has been attained it can be maintained by the explosion, every five seconds, of a pair of 60 per cent. nitrogelatin cartridges, each weighing two ounces. There will thus be required about one hundred pounds of the explosive for each hundred miles of the journey, and the cost, including a very liberal allowance for construction and insulation of the cartridges, should not exceed forty cents per pound. The expense would then be $1.20 per minute, or $72 per hour, being less than forty cents per mile traveled. Three thousand pounds of fuel would thus more than provide for a trans-Atlantic voyage, and the cost thereof should not exceed $1000, which would be inexpensive for a vessel of its probable carrying capacity, which, in addition to fuel and supplies, should easily transport twenty-five adults, consisting of a crew of ten and fifteen passengers. Let man but partially succeed in the field of aerial navigation and there is no doubt but that the maximum of success will follow in much less time than has been required in the evolution of the ocean steamer."

Ex. Doc. No. 20 of the U. S. Senate, 53d Congress, first session, comprises the report of the U. S. Commission on Safe and Vault Construction, which is issued as a volume of 90 pages, illustrated by upwards of 100 cuts and plates. The appendix records the results of the experiments made by Professor Charles E. Munroe and Lieutenant Rodman in attacking safes and vaults by means of nitroglycerin, dynamite, gun-cotton and other explosives.

The experiments were made to demonstrate the relative efficiency of the various systems of construction tested in resisting either "burglarious operations" or "mob violence," it being understood by a "burglarious operation" that the contents of a closed and locked safe should be made accessible within twenty-four hours by the use of materials such as a party of men could smuggle into a bank and which could be used without attracting attention or doing material damage to the surroundings; and by "mob violence," that the vaults are supposed to be in the pos-

session of a mob which has ample time and quantities of explosives at hand, and is indifferent to the noise that is made or the destruction that is wrought, provided the treasure be secured.

Among the many accounts of burglarious operations is one in which a $3000 square laminated safe of the most approved construction was attacked by inserting in the crevice about the locked door 4.8 ounces of nitroglycerin, and in eight minutes after the operation of loading was begun the charge was fired, with the result that the whole of the joint below the door was blown out and a hole made of sufficient size to admit the hand and arm, while the doors and divisions of the interior compartments were completely shattered. On repeating the operation with 4.5 ounces of dynamite the door was torn completely off.

Among experiments made to demonstrate the resistance of structures to attack by a mob was one upon a safe 29 inches cube, with walls 4.75 inches thick, made up of plates of iron and steel. Two charges of untamped dynamite were fired upon the safe. The first charge of 9.5 pounds in weight made a hole three inches in diameter clear through to the interior of the safe, while a second charge of 12.5 pounds enlarged this hole to 5.5 inches.

These dynamite charges were built up in a peculiar way, invented by Professor Munroe. He has stated in these Notes* that he found that when he perforated disks of compressed gun-cotton and detonated these disks in contact with metal, the metal plates could be perforated, though solid blocks of gun-cotton of greater weight failed to effect the perforation of similar plates, and he advanced a theory to account for this action. Acting on this theory when making the experiments before the Safe and Vault Commission, he took a metal can about eight inches in height and of suitable diameter, placed its open mouth downward and bound around it sticks of dynamite so placed that they touched sides; then a solid bundle of sticks was placed on the base of the can and the detonator placed in this. When this hollow cartridge was fired with the open or hollow end "in contact," it was found that plates of metal could be pierced with readiness which would successfully resist attacks by solid charges of the same explosive of many times the weight.

It is believed that this "hollow high explosive cartridge" will eventually find application in warfare, and that by employing it

* Proc. Nav. Inst., 13, 594; 1887, 14, 771; 1888.

in place of the present expensive methods of testing armor plates in vogue at proving grounds there will follow a gain in speed and reduction in expense without any loss in accuracy or reliability.

Mr. Walter D. Field gives in the *J. Am. Chem. Soc.* **15**, 140-144; 1893, **16**, 487-498, 543-549; 1894, an illustrated account of "Pyroxylin, its History and Manufacture," in which he has collated from the patent literature and elsewhere, memoranda regarding the development of this important industry, and illustrations of the various apparatus employed or proposed.

By the term pyroxylin is understood the soluble nitric ethers of cellulose, namely, the di-, tri-, tetra- and penta-nitrates. From the date of the use of pyroxylin in photography, as collodion, by Scott Archer in 1851, the number of its uses has increased until, at the present time, tons of the lower nitrates of cellulose are produced yearly. In the form of celluloid it finds manifold applications. As a varnish it is used on penholders, pencils, silver and brass ware. Articles are bronzed with it as a medium, and an artificial leather has been produced by its aid which has already found a ready market to the extent of many thousands yards.

The portion of the article which is likely to prove of most interest to the student of explosives is that which is devoted to the variation in the composition of the pyroxylin produced with the differences in the strength and proportions of the acids, the time and temperature of exposure, and the relative humidity during nitration, and also that dealing with the behavior of the product toward solvents.

Dr. J. E. Blomène treats of "The Manufacture of Soluble Nitrocellulose for Nitrogelatin and Plastic Dynamites" in *J. Am. Chem. Soc.* **17**, 411-419; 1895, where, after describing what sort of material is required and giving the method of preparing the cotton, he says:

"As is always the case, where a number of nitro-derivatives can be obtained simply by using a stronger or weaker nitric acid and by changing the conditions under which it is used, the tri-nitrocellulose can be obtained in several different ways. The factors to be taken into consideration are:

(1) The *proportion* of sulphuric and nitric acids used in the mixture.

(2) The *strength* of the two acids respectively.

(3) The *length of time* the acid mixture is allowed to be in contact with the cotton.

(4) The *temperature* maintained during the reaction.

(5) The *construction* of the plant itself; and a number of minor conditions, such as the humidity of the atmosphere at the time of the reaction.

I will simply indicate the importance of each one of these conditions and then describe *one* way, which I have found, after numberless experiments, to give satisfaction; that is, to produce a nitrocellulose soluble in nitroglycerol at a reasonable cost.

If too *much* sulphuric acid be used this is likely to attack the cotton *before* the nitric acid begins to act, converting it partly into cellulose hydrate (this will later be converted into a higher nitration degree by the nitric acid, as it is much more readily acted upon than the cellulose and will then form an insoluble nitrocellulose) and partly into glucose, which will again partly be nitrated to nitrosaccharose, which is insoluble in nitroglycerol and, besides, a very dangerous substance to have present. Again, if too *little* sulphuric acid be present it will soon form its highest hydroxide and be unable to absorb more of the water rapidly formed during the reaction, when the nitric acid will become diluted and be unable to nitrate the cellulose. The right proportion of acid mixture is, therefore, of great importance.

If *too strong* sulphuric acid be used the result will be the same as above-mentioned for an excess of it; if too strong or too weak nitric acid be used it is obvious that a higher or lower nitration degree than the one desired will result. It goes without saying, therefore, that the strength of the acids is of utmost importance.

In the reaction between nitric acid and cellulose no fumes are given off, except what is driven off by the heat (in which it widely differs from several other nitration processes), and although the reaction becomes feebler and, eventually, completely stops, when the acid has been diluted to a certain limit it only gradually diminishes in force, and therefore the time has to be so balanced that the lower nitration degrees have been passed without part of the cellulose having been too highly nitrated when it is stopped. Hence the importance of careful regulation of the time.

If the nitration pots are surrounded with water kept at a constant temperature, it will be found that the quickness and degree of the nitration depend, to a considerable extent, upon the temperature of this water. Thus, if the temperature be kept up to a high degree the nitration will be much more rapid, but at the same time experience has shown me that, in this way, a *mixture* of different nitration degrees is much more apt to result than the uniform nitration from one degree to another. Curiously enough, the same result is obtained if no external heat at all be applied, and accordingly in my experience a carefully maintained temperature of 70° C. has been found to give the most uniform result; but no doubt good, and perhaps more economical results can be reached by elevating the temperature of the surrounding water.

It is within the experience of every chemical manufacturer how much the size and construction of the vessels in which the reaction takes place influence the result, and this is fully as true in this industry as in any other. It is especially so as the cotton is so bulky that it is hard to keep every part of it in contact with the acid mixture. Under otherwise the same conditions I have found quite a difference in the product whether it was made on a clear and dry day, or when the day was rainy or cloudy, the more so as the building in which the operation takes place has to be left open to a great extent to allow the acid vapors to be carried away.

Even in very large dynamite works it is not always practicable to adopt the very best appliances for the manufacture of nitrocellulose, because it must necessarily be only a small part of the plant (an average of two per cent. of the ingredients), and can only be conducted by dependence for labor, material, etc., on other parts of the works. In a large plant for the exclusive manufacture of this kind of nitrocellulose the conditions would be more favorable for improvements.

The acid mixture I have found best to use is the following: Nitric acid of 1.430 sp. gr., free from chlorine and such an amount of sulphuric acid as would influence the specific gravity, forty parts; and sixty parts of sulphuric acid of 1.835 sp. gr. The specifications for acids governing the supply for other parts of the works can be adopted for this. It is self-evident that this proportion of acids is only necessary when the work is carried on as hereinafter described, and can be greatly varied under different

conditions. Such an acid mixture as this cannot be stored in iron drums for any length of time and is therefore troublesome to get, if the nitric acid is not manufactured at the works. The nitric acid must be shipped in carboys; the sulphuric acid can be shipped in drums.

In mixing the two acids a sufficient quantity can be mixed at one time to last for two or three days' supply, and then stored in drums, as the acid will hardly, in this short time, affect the iron to any great extent. The mixing is best effected in a wooden tub lined with heavy lead in such a way as to allow a water-jacket of about two inches around it. (A condemned nitro-glycerol apparatus with the coils removed answers this purpose very well.) If compressed air be at hand this should be used as a stirrer by placing a small perforated lead coil at the bottom of the tank and letting the air bubble through the mass, since it is very difficult to get any other kind of stirrer that will stand the acids. The men should be warned to have the earthenware faucet at the bottom of the tank well greased, to tap it very gently, to always use their rubber gloves, and to have an ample supply of water close at hand.

This mixture, although carefully made from acids of 1.430 and 1.835 sp. gr. respectively, will vary in specific gravity from 1.678 to 1.682, but if below or above this, some mistake has been made in the mixing or stirring. The nitric acid should always be dumped in the tank first and the sulphuric acid afterwards, so as to give the latter a chance to mix by gravity as much as possible. Just before using, the acid mixture should be stirred again. For this purpose it is convenient to have a lead-lined tank, with an air-stirrer, of a size to hold one charge for the nitrating pots in use, in which the mixture is stirred up thoroughly and then drawn off for each pot as rapidly as possible.

The arrangement of the nitration pots, of course, must depend on existing conditions, such as size and form of the building, the size of the pots, the material used for confining the water around them, the supply of water of suitable temperature, etc. Under ordinary circumstances I have found it practicable to use earthenware pots sixteen inches deep and thirteen inches in diameter, enclosed in wooden troughs twenty feet long by twenty inches wide, connected by means of leaden pipes. If shorter it is a waste of lumber, if longer they are likely to leak from the pres-

sure. If the troughs can conveniently be made from concrete or brickwork with water-tight mortar, of course they can be extended to any desired length.

Experience has shown two pounds to be the right amount of cotton to be used in one nitration pot. To save time and labor it is important to nitrate as much as possible at one time, but the necessity of getting a uniform product limits the amount; and as the cotton clogs or packs together as soon as wet by the acid mixture, only so much can be used at one time as will allow the mixture to act uniformly on the whole bulk of the cotton, without nitrating the outer portion too much and the inner portion too little. After having tried different amounts I have reached the conclusion that (under the given conditions) two pounds is the maximum that can safely be treated in one nitration pot.

Forty-five pounds of well-stirred acid mixture is weighed out and placed in the pots, which are surrounded by water heated to 70° C. The two pounds of cotton for each pot should be previously weighed out, and ready to be put in so as to have this done as nearly simultaneously as possible. It is now immersed in the acid mixture, turned about a few times with a fork and kept down by a perforated cover. The only reason for using such an excess of acids is that the cotton must be covered by it; if good covers are used, forty pounds or less is enough. Besides the perforated covers, each pot should be provided with solid overlapping covers to keep back the fumes. It is now left for one hour and ten minutes, except that after thirty-five minutes the cotton is quickly turned about with the fork a couple of times and the covers replaced. After this the nitrated cotton is quickly taken up, squeezed with the fork and wrung out in a centrifugal machine. From this it is taken to a large-sized tank well filled with cold water, where it is thoroughly washed. It should be kept in this tank in running water for about one hour. It is well to have a large quantity of water to prevent heating by adherent sulphuric acid, but it is not so important as in the case of gun-cotton, because it is not so easily ignited by the heat generated, nor is the acid as strong as in the latter case. It is then transferred to another tank of the same size. This is conveniently placed below and the nitrocellulose transferred on a wooden slide. Here it is washed in a sal-soda solution. From

this it is taken to a pulping machine or hollender, where it is reduced to a fine pulp. This part of the process is of the greatest importance, as it has been proven time and time again that if insufficiently pulped it is hard, if not impossible, to dissolve it in nitroglycerol. I have found that nitrocellulose which had before been rejected as insoluble, worked very well after it had passed two or more hours in the pulp machine. From the pulp machine it is emptied into a large tank, allowed to settle, and the water filtered off. It is then passed either through a centrifugal machine or a hydraulic press, and thus freed from water as far as possible. It is spread in drying boxes to a depth of about two inches and kept at a temperature of about 80° C. till thoroughly dried. After that it is rubbed through fine screens until as fine as the finest flour. If treated in this way the nitrocellulose will dissolve very quickly in nitroglycerol. Seven per cent. of nitrocellulose dissolves in ninety-three per cent. nitroglycerol in less than twenty minutes to a transparent jelly, and three and five-tenths per cent. gives the nitroglycerol the consistency of syrup. Several hundred analyses of nitrocellulose prepared in this way show it to contain from 20.5 to 21.8 per cent. of NO_3, which very nearly corresponds to the formula of trinitrocellulose. The process carried out in this way is simple and requires no great skill or experience. The cost under ordinary circumstances and with conscientious supervision varies between thirty-five to forty cents a pound. The spent acid must, of course, be taken care of either by regaining it or by using it direct for other chemical processes."

Under the title of "The Manufacture of Smokeless Powder," Oscar Guttmann gives in the *J. Soc. Chem. Ind.* **13**, 575-584; 1894, a description of the methods employed, with illustrations of the apparatus used, generalizing his methods as one is compelled to when so many competitors are in the field and all the processes are so new. The description is preceded by a historical resumé of these powders, and succeeded by a general statement as to their properties and advantages, together with a profitable discussion such as characterizes the meetings of British scientific societies. The author does not often indulge in criticism, but he seems to have fallen into error in his remarks on the formation of indurite. Altogether, the paper is a valuable one, as the former articles by this author have been, and it is worth reading in full, and critically.

English Patent No. 6129, April 9, 1891, has been granted the Dynamite Actiengesellschaft Nobel of Vienna, for "Improvements in the Manufacture or Production of Gunpowder or like Explosives," the object of the invention being the manufacture of a smokeless powder from nitrocellulose without having added substances which dissolve or gelatinize the nitrocellulose.

For this purpose nitrocellulose in a state of fine meal is mixed with di- or tri-nitro derivatives of benzene, toluene, xylene or naphthalene, the proportions of nitrocellulose to the nitro derivatives depending on the projective force required, varying from 99 to 70 parts by weight of the former to 1 to 30 parts by weight of the latter.

The Boston *Herald* of September 6, 1894, announces that one of "the largest blasts of dynamite that has ever taken place in a quarry occurred at 5 o'clock last evening at the Palisades quarries, about a mile and a half from Fort Lee, New York.

Two shafts were sunk in the face of the palisades, about 65 feet in depth, and into each shaft fully 1500 pounds of dynamite were placed.

When everything was in readiness, the connections were made and the mountain was shorn of about 1200 feet of surface. This displacement extended about 500 feet, on an average, into the rock. The weight of the rock displaced is estimated at 80,000 tons.

The shock was felt at Fort Washington, directly across the river, owing to the stratum of rock which extends to that point."

Among other large blasts we may note that occurring at this same Fort Lee quarry in 1893, in which 4000 lbs. of dynamite were fired and 100,000 tons of rock removed, and the one occurring the same year at the Dinorwic quarries, Llanberis, when 2½ tons of gelatine dynamite were used in the charge and 180,000 tons of rock were displaced.—*Ann. Rept. H. M. Insp. Exp.* for 1893, p. 74.

The New York *World,* February 3, 1892, reports an explosion of alcohol vapor which occurred at Rummel Company's hat factory, Newark, N. J., on February 2, and through which three men were killed and two wounded, while the building, a large two-story one, which had been recently erected, was unroofed, its side walls were shattered, and the glass in the windows of this

and the surrounding buildings for a considerable distance about was destroyed. The description of what occurred is very vague, but it appears that a new machine called an alcohol condenser had recently been erected in the factory; that on the day of the accident it was out of order, and that, at the time of the explosion, a plumber was at work repairing it. As 158 men and women were at work in the building at the time of the explosion, it is remarkable that the casualties were so light.

On the evening of March 9, 1893, a startling explosion occurred in the freight station of the Midland Railway at Whitecross Street, London, which, being seemingly due to a mysterious agency, gave rise to considerable anxiety and led to an investigation the following day by Col. Majendie, H. M. Chief Inspector of Explosives, and Dr. A. Dupré, Chemist to the Home Office.

The results of this investigation are given by the latter in *J. Soc. Chem. Ind.* **13**, 198-200; 1894, under the title of "Note of an Interesting Explosion caused by Sodium Peroxide," in which it is shown that when this powerful oxidizing agent, which is now being manufactured on an extended scale, is mixed with wood meal, shavings, hay, cotton, wool, sulphur, bisulphite of sodium or other combustible bodies, the mixture is set on fire or exploded by simply moistening with water. In fact, a slightly rough deal board may be set on fire by merely covering it with a layer of peroxide and dropping water on it. When once the combustible has taken fire a very fierce combustion results so long as any peroxide is left, the effect being greatly enhanced by the melting of the peroxide, which, wherever it flows, sets fire to everything combustible. Hence sodium peroxide differs from most oxidizing substances in the fact that its power is developed by either fire or water.

These properties of the peroxide present a fresh danger to carriers. In the accident investigated, sodium peroxide was found to have been present, and it had apparently become wet by some solution of a sulphur compound packed with it. If the peroxide is put up, as it easily may be, in hermetically sealed tins and packed in mineral wool or infusorial silica, its transportation is without danger.

The attention of hygienists has been called to the consideration of "Modern Explosives in Relation to Health," owing to the fact that within recent years complaints have been made by those

engaged in coal and other mines, where modern "high explosives" were used for blasting, that the fumes resulting from the explosion of these bodies produced deleterious effects, hence, in compliance with the wish of the workpeople, a committee was appointed in September, 1889, by the Durham Coal Owners' Association, consisting of representatives of both masters and men, with two of H. M. Inspectors of Mines, to consider the question, and report whether the fumes produced by the combustion of tonite and roburite were injurious to health, power being given to the committee to call in professional advisers. Mr. Thomas Bell, H. M. Inspector of Mines, was appointed chairman; Professor P. Bedson, chemical adviser, and Drs. Drummond and Hume, medical experts.

Trials were made with tonite, roburite and gunpowder at several collieries, the experiments being conducted in the following manner: First, samples of air were taken at the intake and their composition ascertained by analysis. Then, during the firing of the shots, samples of the vitiated air were taken at the return. The apparatus used for the collection of these samples consisted of a zinc aspirator of about 600 cubic inches' capacity, which, having been filled with water, was slowly emptied, so that the time occupied in displacing the water completely by air was about an hour. The vessel was then securely sealed. A second quantity of air was taken in a glass pipette a quarter of an hour after starting the aspirator, and half an hour after a sample of air in a bottle of 30 cubic inches' capacity was collected, in which the amount of carbonic acid was subsequently determined. The air containing the fumes produced in the immediate vicinity of the shot-firing was collected in a different manner, after unsuccessful attempts had been made to obtain representative samples by means of the zinc aspirators. For this purpose large brass cylinders were employed, 24 inches long and 6 inches in diameter, with a capacity of about 680 cubic inches. At one end of the brass cylinders were two apertures, terminating in narrow brass tubes, securely closed by glass plugs fixed in pressure tubing. These cylinders were first exhausted by an air-pump and then closed in the manner described, being tested carefully with a mercury gauge before each experiment to see if the vacuum had been maintained. A sample of the fumes produced was collected immediately after the firing of the shot by opening a clamp closing one of the apertures to the cylinder, by which means it was quickly filled.

A glass tube filled with glass wool, through which the gases passed before entering the cylinder, removed all solid matter from the mixture of air and gases resulting from the explosion. Naturally, the proportion of air to fumes collected in this manner must vary considerably with different experiments, as the time occupied in reaching the scene of the explosion, and the rate of the air-current through the mine, both influence the rate of diffusion of the fumes. The samples taken for the estimation of carbonic acid, both at the intake and at the return, were examined immediately on reaching the surface. The other two samples of air collected at these two places served—(*a*) the one collected in the pipette for the estimation of the oxygen, and (*b*) the sample taken in the zinc aspirator for the complete analysis of the air. Similarly, the samples taken in the brass cylinders at the shot-firing district were used for the determination of oxygen, nitrogen, carbonic acid and also for other gaseous bodies, while smaller samples taken in exhausted pipettes were used for determining the ratio of carbonic acid and of oxygen to nitrogen. These experiments lead to the following conclusions:

The roburite used consisted of a mixture of chlorodinitrobenzene with ammonium nitrate. Three sets of experiments were made with it. (1) The roburite was fired by Bickford's fuze. In all twenty-three shots were fired, there being a total weight of 5.5 pounds of the explosive. Samples of air were taken at both the intake and the return. During the shot-firing four aspirators were filled to examine the fumes. The fumes from four shots were tested especially with blood for carbon monoxide, with negative result. Special examination of the contents of the aspirators for carbon monoxide, nitric oxide and hydrochloric acid showed that all these deleterious gases were absent. A mouse was suspended in a cage in the return during the whole time and subsequently drowned; a spectroscopic examination of its blood gave no indication of carbon monoxide. (2) At the second visit, again twenty-three shots were fired, having a total weight of 4.7 pounds. Samples were collected as before. The air at the return, and the fumes, both showed traces of carbon monoxide. The method used for testing and estimating the CO on this occasion consisted in passing the air through a solution of palladium chloride, which is reduced by carbon monoxide, with the precipitation of metallic palladium. The samples in the brass cylinders from the neighborhood of the shot-firing showed, when examined by this method,

amounts of CO varying from 4.2 to 1.9 parts per 10,000 parts of air, or 0.042 to 0.019 per cent. (3) On the third experiment roburite and gunpowder were tried together, roburite being fired from three places and gunpowder from three places. In all, six charges of the former were fired, weighing 2.25 pounds. The samples taken in the return showed no indication of carbon monoxide, but the fumes, which on this occasion appeared to clear away but slowly, contained CO, the amount being 24 volumes per 10,000 in one sample collected on the face of the coal in the midst of the fumes. A second sample collected on the fumes beginning to lift gave only 1.4 volumes per 10,000, or .014 per cent., thus showing that the air-current acts immediately in clearing away the fumes.

The tonite consisted of equal parts of gun-cotton and barium nitrate, intimately mixed and compressed into cylindrical cartridges with a cylindrical hole at one end. In firing, the cartridge was surrounded by a so-called flame-extinguishing mixture packed in a brown paper bag. As before, Bickford's fuze was used for firing. Two sets of experiments were made, both at South Hetton. On the first occasion nineteen shots were fired, being 6.29 pounds of tonite. The arrangements for collection of the samples were similar to those in the roburite experiments. Examination of the blood of a mouse exposed to the return air showed the presence of CO, but this was the only indication obtained on this occasion of the presence of any deleterious gas. Traces of some combustible gas, either CO or CO and marsh gas, were found in both the intake and return samples. At the second visit thirteen shots were fired, weighing 4.43 pounds. Three cylinders and four pipettes of the fumes were collected. The samples were examined for CO by aspiration through palladium chloride. The results showed it to be absent in the intake air, present in traces in the return, while amounts from 1.9 to 4.8 parts per 10,000 were found in the fumes.

Gunpowder.—Two sets of experiments were conducted with this explosive, one alone and the second in conjunction with roburite. (1) Twenty-six shots were fired, representing 7.38 pounds of gunpowder. A distinctive feature of these experiments was the marked visibility of the fumes produced, as compared with those from tonite and roburite. There was also the characteristic odor of sulphuretted hydrogen. Traces of CO were found in the fumes and also in the return air. (2) These experiments with

gunpowder were conducted simultaneously with a series with roburite, so as to obtain fumes from each produced under the same circumstances. It was found in the experiments conducted at Haswell that, owing to the increased air-current, the samples of fumes were more diluted with air than those obtained in previous experiments. Hence a second series became necessary. Six shots were fired, representing 3.33 pounds of gunpowder. No CO was found in the intake air, and only traces in the air from the return and the fume samples.

As previously stated, the solid matter of the fume was filtered from the gaseous constituents by means of glass wool. On analysis it was found to consist for the most part of finely divided coal. In the case of roburite no indication of the presence of nitrobenzene was observed in the solid matter of the fume. In some of the experiments after firing roburite an odor of bitter almonds was noticed, but beyond this no evidence of the presence of nitrobenzene or a similar body was obtained. The presence of carbon monoxide in the fume, which is not a constituent of the complete combustion of tonite and roburite, was shown to be partly due to the burning of the fuze. Some may also be formed by the passage of the heated carbonic acid over the coal. Analysis of the tonite and roburite used showed them to have the following composition:

Tonite.	No. 52.
Barium nitrate	48.21
Potassium nitrate	1.77
Gun-cotton	49.21
Moisture	1.58
	100.00

Roburite.	No. 50.	No. 51.
Moisture	1.14	0.66
Ammonium nitrate	83.35	86.30
Chlorodinitrobenzene (sol. in ether)	11.67	11.74
Matter (insoluble in ether and water)	3.14	1.09
Fixed residue	0.70	0.21
	100.00	100.00

No. 51 is a sample of roburite of more recent date than No. 50. Apparently now more ammonium nitrate is added.

The medical report by Drs. Drummond and Hume shows that although they inquired into every case of suspected illness produced by exposure to the fumes, they could find no evidence of acute illness being caused. Of the shot-firers examined only one made any serious complaint, and apparently the dyspepsia from which he suffered was existent before his working with the explosive.

The general conclusions arrived at by the experts were that (1) the fumes produced by tonite and roburite are not more dangerous than those from gunpowder; (2) nitrobenzene is apparently not produced by the combustion of roburite; (3) the carbon monoxide produced is present only in traces; (4) an interval of five minutes should be allowed to elapse before the hewers re-enter the scene of firing; and (5) that, as a portion of the gases in the fumes comes from the fuze, the charges should be fired by electricity.

A more modern explosive than roburite, and one which is similar in nature, is the new "ammonite." The main work of the committee was over before the introduction of this new body; otherwise, in view of the probable general use of ammonite for blasting, it would have been interesting to have examined the fumes produced by its combustion. Ammonite contains 81.5 parts of ammonium nitrate and 8.5 parts of mononitro-naphthalene. It is of equal projectile force to roburite, and superior to tonite. It cannot be exploded by concussion, and burns quietly on an ordinary fire. Its properties are not affected by freezing. It requires rather a strong detonator to produce explosion.—*Industries,* **11**, 182; 1891.

It may be noted here that carbon monoxide, CO, is the most objectionable of the gases found in the products of incomplete combustion or explosion, since as, when inhaled, it combines with materials in the blood corpuscles to form a compound which prevents the blood from performing its proper functions, it exerts a distinct toxic effect. The presence in the atmosphere of one-half of one per cent. of carbonic oxide, or even less than one-half of one per cent. under certain conditions, is fatal to animal life.

Under the title "Les Explosifs Industriels, Le Grison et Les Poussières des Houille,"* M. J. Daniel has collected a large mass

* Lg. 8vo. Vol. I, 348 pp. Vol. II, 444 pp. Whittaker & Co., London, 1895.

of useful and interesting information from original sources which he very properly cites, but while aiming to produce a work useful as a guide to young engineers in the practice of mining, he has dwelt more fully upon the details and theories of explosives than is necessary in a practical guide, and yet not with sufficient fulness for a treatise on explosives, while space is also occupied by irrelevant descriptions of torpedoes, pneumatic guns and other devices. Being a Directeur de la Compagnie des Explosifs Sécurite, M. Daniel is naturally at his best in his discussion of the composition, properties, tests and applications of these recent explosives, and those interested in the preparation or use of flameless explosives, or in the controversy going on between the promoters of the different products offered, will find this part of the work of value. This book bears testimony to the fact that the producers of these French works have not yet discovered what a convenient and labor-saving device an index is.

"The Manufacture of Explosives"* is the title under which Oscar Guttmann presents his new work, which is issued in two large volumes with 328 illustrations. The arrangement of this book is one which has been made familiar in Désortiany's *Traité sur la Poudre*, and like this work, Guttmann's first volume is devoted partly to the manufacture of "Black Powder" and partly to a description of the raw materials used in the manufacture of the explosive substances. Volume II treats of gun-cotton, nitroglycerin, dynamite, nitro-substitution explosives and smokeless powders, while a considerable space is given to apparatus for testing the velocity, pressure and power of explosives, the whole being followed by some seventeen pages of a bibliography which is far from being exhaustive. From his occupation as a builder of works and inventor of apparatus for use in the manufacture of explosives, Mr. Guttmann has had excellent opportunities for becoming familiar with the art, but it is not to be expected that much will be published in such a work that has not already been made accessible in periodical or patent publications, so that the work is to some extent historical and suggestive. It is in this light that this work is most valuable to American readers, but it fails to describe American methods and products, though they differ materially from those in vogue in Europe.

* Lg. 8vo, 283 pp. E. Bernard & Cie., Paris, 1893.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A MESSENGER-PIGEON SERVICE FOR NAVAL PURPOSES.

By Ensign Edward W. Eberle, U. S. Navy.*

During the absence of Professor Marion in the summer of 1895, the writer of this paper was in charge of the homing pigeons of the U. S. Naval Academy loft; and, in October, a report, from which the following paragraphs are taken, was made to the Superintendent of the Naval Academy:

"2. During the summer eighteen pigeons made a total of one hundred and ten flights. The long-distance flight of the summer was made by a pigeon that was released from the U. S. S. Monongahela when one hundred and two miles off Cape Henry, or about two hundred and fifty miles from the home loft. This pigeon was out over night, and it had about twelve hours of daylight from the time of its liberation to the time of its arrival at the home loft, thus making an average of about twenty-one miles per hour for the two hundred and fifty miles.

3. In the swiftest flight of the summer the pigeon was liberated at Norfolk, Va., and arrived at the home loft three and three-quarter hours later, thus making an average of forty miles per hour for one hundred and fifty miles.

4. In previous years it was the practice to fly the pigeons in the Chesapeake Bay from the neighborhood of the Virginia Capes to the home loft, and, consequently, the pigeons were not familiar with the coast-line north of the Virginia Capes.

5. During this summer pigeons were liberated at different points off the coast of Delaware and New Jersey in order to see if

*The writer of this paper desires to thank Professor H. Marion, of the Naval Academy, for much valuable information on the subject of homing pigeons.

they would mistake Delaware Bay for the Chesapeake, and also to record their times of flight from points off a coast unfamiliar to them. In all of these trials the pigeons returned to the home loft, and some of them made very good records, considering the fact that they had never flown along that portion of the coast.

6. Pigeons that were liberated from the U. S. S. Bancroft when forty miles off the Fenwick Island Shoal, made their first flights to the home loft in twelve hours of daylight. If they flew across Delaware and eastern Maryland in a direct line for Annapolis they averaged about twelve miles per hour; but if they flew down the coast and then up the Chesapeake Bay, they averaged over twenty miles per hour for two hundred and fifty miles.

7. Pigeons liberated from the Bancroft when fifty miles off Cape May made their first flights to the home loft in eleven hours of daylight. If they flew across Delaware Bay, Delaware, and eastern Maryland in a direct line for Annapolis they averaged about twelve miles per hour.

8. These results are very good when it is considered that the pigeons had never flown along that portion of the coast, and had never flown across Delaware or eastern Maryland, or in the neighborhood of Delaware Bay.

9. A pigeon that had made one flight from off Fenwick Island Shoal was liberated from the Bancroft three weeks later when fifty-five miles off Atlantic City, with the result that it increased the speed of its previous flight by about seven miles per hour.

10. I conclude, from these trials, that pigeons can be trained in a short time to fly from points off a coast that is unfamiliar to them.

11. Five pigeons were taken to Gardiner's Bay in the Bancroft and there put on board the yacht Medusa. After the Medusa sailed from Gardiner's Bay the pigeons were kept below decks in a small basket, and after eight days of bad weather at sea one pigeon was liberated off Winter Quarter Shoal and it arrived at the home loft nine hours later. This pigeon had been away from the home loft for twenty-two days, and it had never flown along that portion of the coast. If this pigeon flew in a direct line across Delaware and eastern Maryland it averaged about twelve miles per hour; but if it flew down the coast and up the Chesapeake, it averaged about twenty-two miles per hour for two hundred miles.

13. The flights of the pigeons of the Naval Academy loft have been of an experimental character, and much more satisfactory results might be obtained from a station located on the coast. By regular and systematic flights over a limited portion of the coast, homing pigeons can be so trained as to form a most reliable and rapid method of communication between ships off the coast and the home station.

14. In time of peace the messenger-pigeon service could be made very useful in many ways, and thus the pigeons could be kept in constant training, so that in the event of hostilities they would be in readiness to render valuable service to our cruisers.

15. The messenger-pigeon service would be especially valuable in the event of hostilities with a government that has possessions near our coast; for then our swift cruisers could scout along the enemy's coast and still be in constant communication with the home station, thus keeping the commander-in-chief informed of all movements of the enemy.

16. On account of the distance from the sea-coast, the Naval Academy could not be made valuable as a pigeon station except for breeding and experimental purposes.

17. As the Navy Department has not undertaken the establishment of a messenger-pigeon service, I have not, in this report, proposed a system for establishing stations or for training the pigeons; and I have not enumerated the many valuable results that could be obtained, both in time of peace and in time of war, from this service."

* * * * * * * * * * *

Since the above report was written, two very interesting flights have been made from the U. S. S. Amphitrite, at anchor in Lynn Haven Bay—a distance of one hundred and twenty-five miles from Annapolis. At 9.15 A. M., December 7th, two pigeons were liberated from the Amphitrite, and they arrived at the Naval Academy loft, in the afternoon, with messages from Captain W. C. Wise, U. S. N., as follows:

To Rear Admiral Bunce, Navy Yard, New York:

Amphitrite anchored in Lynn Haven Bay waiting for favorable weather for target practice. Delayed by a snow-storm.

To Prof. Marion, Naval Academy:

My compliments, and wishes that this very valuable service be greatly encouraged by the Government. I deem it of great importance, and will do anything in my power to help it.

As the Amphitrite was not within telegraphic communication, the pigeons were sent with messages, and, although very unfavorable weather prevailed at the time of liberation, they arrived in very good time.

The message for Admiral Bunce was telegraphed to the Navy Yard, New York.

When reviewing the results of these flights made by the pigeons of the Naval Academy loft, the fact must be remembered that the pigeons have not been kept in training. The only opportunities for exercising them in long flights have been from the practice ships during the summer months, and from the Government vessels that have occasionally visited Annapolis. Consideration should be given to the fact that these birds had not previously been set free from positions at sea north of the Virginia capes, and that the trials were made for the purpose of determining whether or not homing pigeons, if liberated off a coast with which they are unfamiliar, can find their way to the home loft within a reasonable time. In all the first flights the homers did fairly well, and in the few second flights over the same general route the time was much decreased.

During good weather a trained pigeon will fly successively over the same general route at a speed of forty to fifty miles per hour. In fact, the remarkable speed of seventy miles an hour has been made. Moreover, the messenger can be relied upon to reach home in all kinds of weather. Pigeons trained for flying over the land have frequently made from four to five hundred miles in one flight, and it is reasonable to suppose that they may be trained to fly about four hundred miles over water. The ordinary flights should prove more reliable over water than over land, because the messenger cannot be tempted to loiter with other pigeons or to stop for food. It might be well to have a reserve of the best pigeons for very long flights from sea, say from 200 to 400 miles. Such birds would necessarily be released in the morning, and it would probably be of service to train them at gradually increasing distances by always releasing them in the morning, so that their uniform habit at sea would be to fly away from the sun (or towards it in Pacific waters) when first set free. Four hundred mile flights over water would seldom be necessary, and two hundred miles off the coast would probably be the limit of reliable and swift flights, while the majority would be under one hundred and fifty miles.

Throughout Europe, thousands of messages are sent daily by pigeon post, and the regularity of the speed over established routes is remarkable. Each important naval power maintains, as well, an efficient messenger-pigeon service for the use of its navy. Many such pigeon stations are located along the coast of France, Spain, and Italy; and Great Britain has a very efficient station at Gibraltar. Homing pigeons have been used with excellent results during French naval manœuvres, having been released from ships under conditions such as appertain to actual warfare and made good flights, thus showing that they are not seriously frightened by the firing of heavy guns. For example, on one occasion pigeons were released from a flotilla of torpedo boats during an attack on the Squadron of the North, when off Brest, and the messages were received at Brest in the usual time for the distance covered. There are many private lofts in the United States, but the pigeons cannot be used for naval purposes because they are not trained to fly over sea, and because their home lofts are not located at desirable points. In the event of hostilities, our cruisers employed on scouting or patrol duty off the coast would have to leave their stations and steam to land when necessary to send important information to the Navy Department.

First-rate naval powers, more especially those with long stretches of coast-line, realize the importance of using vessels as scouts in time of war. Fast merchant steamers of large coal capacity are well fitted for scouting purposes. A proper organization of such scouting vessels into a scouting division would prove a particularly valuable aid to a fleet of battle-ships and to the military stations along the coast. It may be remarked that a small fleet of battle-ships with an efficient scouting service, by using its information to decide when to strike and when not to strike, can so baffle and worry a superior enemy, which it cannot actually defeat on equal terms, as to keep him always on the defensive—pursuing a Fabian policy adapted to the sea.

In the event of hostilities between two nations of equal naval strength, the one that has the more efficient scouting division will have the advantage, more or less decided according to the greater or less superiority of this division. In order to obtain the best service from scouting vessels, it is necessary that they should have rapid and reliable communication with the shore from various distances at sea, and the only way of accomplishing

this is by means of homing pigeons. The nation that has a number of twenty-knot cruisers of large coal capacity, and homing pigeons trained to make swift flights from various distances off the coast, will have an ideal scouting division.

A period of eighteen months or two years will be necessary to establish an efficient messenger-pigeon service for naval purposes. The pigeons must be confined at the new stations for about one year in order to make them forget their old home or homes, and to acquaint them with their new surroundings. Then they must be trained to fly to the home station from positions off the coast, beginning with short flights and gradually increasing the distance. By constant practice for six months the pigeons could probably be relied upon to average thirty-five miles or forty miles per hour for distances of one hundred and fifty miles. The most satisfactory results would be obtained by flying the pigeons over a limited portion of the coast-line; that is, having a station located on or near the Atlantic seaboard, fly the pigeons of that station from positions as far off the coast as desired, but within certain limits of latitude—say about seventy-five miles north and south respectively of the latitude of the station. By this system the pigeons of each station could be made very familiar with one hundred and fifty miles of the coast-line, and our entire seaboard would be divided into equal sections, with a station in each located near the middle point. When released from a ship at sea, pigeons fly in the direction of the nearest land, and it is almost imperative that they should be familiar with its appearance. For the benefit of stragglers, the pigeon lofts along the coast should be of the same color and construction, so that if a messenger loses its bearings and is unable to find its own loft it will probably find and go to another, whence the message will be forwarded by telegraph. Two divisions of the messenger-pigeon service thus organized, one on the Atlantic and one on the Pacific coast, would certainly be very useful.

The naval pigeon stations should be located on or near the coast at well fortified points, or at points inaccessible to an enemy's war vessels. They might be connected directly by telegraph; and they should certainly be connected with Washington and the various naval stations, and with all military stations and cities on the seaboard. Our most important stations would be those on our coast nearest adjacent foreign territory, for, in the

event of hostilities with a government having such possessions, our fast cruisers could scout the enemy's coast, keeping a constant watch on the ports used as rendezvous for the enemy's fleets, and still be in communication with the home station. Our most important stations on the Atlantic coast would thus be at Key West, little over two hours flight from Havana, and in the neighborhood of Bar Harbor, Maine. Our most important station on the Pacific coast would be at Port Townsend or at Port Angeles, State of Washington, only one hour's flight from Esquimault.

Charts should be made containing the locations and ranges of the pigeon stations, so that plotting the ship's position on the chart will immediately show which pigeons may be flown from that position. For example, the pigeon chart would indicate that Norfolk pigeons could be flown from positions off the coast between the parallels 38° 05′ N. and 35° 35′ N., or in other words, between the parallels seventy-five miles north and south respectively of Norfolk. To avoid confusion and loss of time in the selection of messengers, the pigeon cote for a ship should be so constructed as to have a small compartment for each station on the coast, and the number or name of a station, as well as its limiting latitudes, should be stamped on the door of the corresponding compartment. A ship about to leave port for a cruise between New York and Norfolk would receive baskets of pigeons by express from New York, Norfolk, and the intermediate stations, and these pigeons would be put at once in the proper compartments of the cote. When a pigeon arrives at any station, its message should be telegraphed at once to the proper destination.

An efficient messenger-pigeon service could be obtained by locating stations on the Atlantic coast at or near the following points: Bar Harbor, Boston, Chatham (Mass.), Newport, New York, Delaware Bay, Norfolk or Fortress Monroe, Beaufort (N. C.) or Cape Lookout, Port Royal, St. Augustine, southeast coast of Florida, Key West, Tampa, Pensacola, Port Eads and Galveston. On the Pacific coast: at Port Townsend or Port Angeles, Astoria, Empire City (Oregon), Cape Mendocino or Eureka, San Francisco, Port Harford, Wilmington (Cal.), and San Diego. By this system a ship would be within range of a pigeon station from any position along the coast. The above places have rail-

way communication, so that the pigeons could be sent rapidly to any port along the coast; and even in time of peace all government ships cruising along the home coast should have pigeons on board, so as to be able to report accidents, wrecks, and progress of the cruise. Pigeons have been confined on board ships for over thirty days, and when released have made good flights to the home loft. They should occasionally be released from ships during target practice in order to accustom them to the conditions of battle.

In peace times the pigeon service could be made very useful in many ways other than those mentioned, and the pigeons could thus be kept in constant training. They would be very useful to the Light House Service, being taken by the lighthouse supply vessels and left at the lighthouses and lightships, to be used as necessity or pleasure might demand. During the severe weather of the winter months, the pigeons would often be found especially useful to lightships and life-saving stations for the purpose of reporting wrecks, ships in distress, accidents, or lack of supplies. Cable communication with lightships is frequently interrupted, and pigeons may become the only practicable messengers. They would be taken to the lightships at least once a month and there kept in proper cotes until despatched on service.

A regular pigeon service is in use between Sable Island lighthouse and Halifax, a distance of about one hundred and fifty miles. This service would become very useful to Halifax in case of the approach of a hostile fleet. If the cruises of government vessels along the coast are not frequent enough to keep the pigeons in training, they may be flown from steamers engaged in the coastwise trade. Government cotes could be put on board, though baskets would suffice, and the captains of the steamers would probably be very glad to practice the birds, being fully repaid for their trouble by having at hand reliable messengers for reporting accidents, delay of the vessel, or need of assistance.

In time of hostilities we would find much difficulty in protecting the cities along our extensive coast-line, even if we possessed a naval force as large as that of Great Britain or France. It would not be wise to scatter our battle-ships and armored cruisers along the coast and thus be so weak at every point as to be unable to attack or withstand an enemy's fleet. Our probable plan would be to concentrate the battle-ships and armored

cruisers at two or more strategic points, to station monitors and torpedo-boats at various ports, and to use the fast cruisers for patrolling and for destroying the enemy's commerce. The coast-line would probably be divided into sections, and cruisers of the Columbia and Cincinnati type would be used for patrolling these sections, thus forming a continuous picket line. In order that the patrol vessels or scouts may perform efficient service, they must have reliable pigeon communication.

A large fleet of battle-ships, armored cruisers, and protected cruisers approaching the coast to make an attack on a fortified port, or in search of a hostile fleet, would be steaming, probably, less than twelve knots per hour; consequently, the fast scout, which has been under full steam since sighting the smoke of a large fleet, can easily escape from any pursuing cruisers. Upon being chased, the scout should, if possible, lay a course similar to the apparent course of the enemy's main fleet; so that, when the chase is abandoned, the fleet may again be sighted and more information despatched to the shore station. By keeping a long distance in advance or inshore of a hostile fleet—always, if possible, keeping it in sight, however—a scouting vessel, by despatching pigeons, may be able to keep the shore stations informed of the fleet's movements until it is actually sighted from the land. If one scout should lose sight of the hostile fleet, another would probably pick it up later, and pigeons would carry the news to the shore; thus all the forts and all the ships along the coast could be informed of its approach, and of its general course, speed, and strength.

For the purpose of illustrating the usefulness of the messenger-pigeon service, let us assume: (1) that hostilities exist between the United States and a first-rate naval power of Europe; (2) that the United States has an efficient messenger-pigeon service; (3) that her fast cruisers and the fast steamers of the naval reserve are stationed as scouts along the coast from Cape Sable, Nova Scotia, to Galveston; (4) that the scouts have orders to cruise as far as one hundred miles from the coast and to destroy the enemy's commerce, but if the enemy's fleet is sighted the scouts are to keep in touch with it as long as possible and despatch pigeons with information of its movements, speed, and strength; (5) that the scouts are not to engage the enemy's cruisers sent in pursuit, except as a last resort when hard pressed; (6) that the

Columbia is ordered to scout from Cape Sable, Nova Scotia, to Browns Bank, the St. Paul from Browns Bank to Georges Shoal, the Raleigh from Georges Shoal to New South Shoal lightship, and the Cincinnati from New South Shoal lightship to Montauk Point; (7) that these vessels are supplied with pigeons from all stations on the New England coast and from the New York station; (8) that the battle-ships and armored cruisers are organized in two fleets—the Northern Fleet being stationed in the vicinity of Long Island Sound or New York, and the Southern Fleet at the entrance of Chesapeake Bay; (9) that coast-defense vessels and torpedo-boats are stationed at ports along the coast—three monitors, one ram, and four torpedo-boats at Newport for the protection of the entrance to Long Island Sound, and three monitors and two torpedo-boats at Boston. On June 15th, at 6 P. M., the following pigeon message is received at the Bar Harbor station:

U. S. S. COLUMBIA,
At sea, Lat. 42° 55′ N., Long. 65° 40′ W. (31 S. S.W. Cape Sable),
2 P. M., June 15, 1896.

TO THE SECRETARY OF THE NAVY:

Have just sighted smoke of a large number of vessels to N'd and E'd of Cape Sable, apparently standing to S'd and W'd. I will try to ascertain nature and course of the vessels.

COMMANDING OFFICER.

Upon the receipt of this message, orders are telegraphed to the Northern and Southern fleets to be ready to sail at a moment's notice, and the message is telegraphed to all naval and military stations on the New England coast.

On June 15th, at 7.30 P. M., two pigeons arrive at the Bar Harbor station, each with the following message:

U. S. S. COLUMBIA,
At sea, Lat. 43° 03′ N., Long. 65° 31′ W.,
3.15 P. M., June 15, 1896.

TO THE SECRETARY OF THE NAVY:

Have just sighted a large fleet—probably twenty vessels—to N'd and E'd of Cape Sable, standing about S. W. by W. (mag.) to S'd of Georges Shoal, at rate of about nine or ten knots. Will try to keep in touch of fleet until dark, if not chased, and will then try to lay a course parallel to that taken by fleet.

COMMANDING OFFICER.

Upon the receipt of this message, the Northern fleet is ordered to take station off Newport, and the Southern fleet is ordered to proceed with all speed to New York. All naval and military

stations on the northern coast are informed of the approach of a large fleet.

On June 16th, at 9 A. M. and 9.35 A. M., pigeons arrive at the Chatham, Mass., station, each with the following message:

U. S. S. COLUMBIA,
At sea, Lat. 41° 21′ N., Long. 67° 14′ W.,
5 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Lost sight of enemy's fleet yesterday at 5:30 P. M., when we were in Lat. 42° 37′ N., Long. 66° 17′ W., having been chased by three cruisers until after dark. Fleet was still steering about S. W. by W. (mag.), to S'd of Georges Shoal, and had been on that course for about three hours. Made out mast-heads of eighteen vessels. Have not sighted the fleet this morning, but I hope to pick up smoke very soon.

COMMANDING OFFICER.

The Northern fleet is kept in readiness to sail at a moment's notice, in order to intercept the enemy's fleet if it should head for Boston.

On June 16th, at 12.45 P. M. and at 1.20 P. M., pigeons arrive at the Chatham, Mass., station, each with the following message:

U. S. S. RALEIGH,
At sea, Lat. 41° 02′ N., Long. 67° 51′ W.,
10 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have sighted a large amount of smoke bearing about S. E. by E. (mag.) It is probably smoke of a large number of vessels in company standing to the W'd. I will try to learn something more definite.

COMMANDING OFFICER.

and at 2.25 P. M. the following message is received at the same station:

U. S. S. RALEIGH,
At sea, Lat. 40° 52′ N., Long. 67° 50′ W.,
11.30 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have just sighted a large fleet—probably fifteen or twenty vessels—on bearing E. by S. (mag.). Fleet is standing about West (mag.) to S'd of New South Shoal Lt. Sh., at a speed of eight or nine knots. Two vessels have just been detached from fleet and evidently intend to chase me. I am standing for New South Shoal Light Ship.

COMMANDING OFFICER.

By this message it is seen that the enemy was standing too far to the S'd for an attack on Boston, and was evidently bound for Newport or New York. Consequently, a despatch vessel is sent from New York to intercept the Southern fleet and give

orders to the commander-in-chief to take station off Montauk Point, as soon as possible, in order to intercept the enemy, to station a despatch vessel within signal distance of the Montauk Point signal station for the purpose of receiving orders or information from the commander-in-chief of the Northern fleet, and to be ready to move with all speed to the support of the Northern fleet.

At 5.30 P. M. and 5.45 P. M., June 16th, pigeons arrive at the Chatham station, each with the following message:

U. S. S. COLUMBIA,
At sea, Lat. 40° 31′ N., Long. 68° 17′ W.,
3 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have again sighted smoke and mastheads of a fleet bearing E. N. E. ½ E. (mag.), and standing about W. ½ S. (mag.), to S'd of New South Shoal. Speed eight to nine knots. Fleet must contain fifteen or twenty fighting vessels, and has steered the same general course since first sighted by us off Cape Sable yesterday at 2 P. M.

COMMANDING OFFICER.

At 5.20 P. M. the following message is received at the same station:

U. S. S. RALEIGH,
At sea, Lat. 40° 38′ N., Long. 68° 55′ W.,
3.15 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

We have lost sight of the enemy's cruisers after having been chased for three and one-half hours, and we will now attempt to find enemy's fleet before dark. My last message was sent at 11.30 A. M. to-day, and stated that a large fleet was sighted bearing E. by S. (mag.), when we were in Lat. 40° 54′ N., Long. 67° 50′ W., and that it was standing on a course about West (mag.) to the S'd of New South Shoal, at a speed of eight or nine knots.

COMMANDING OFFICER.

and at 7.10 P. M. and 7.30 P. M. the following message in duplicate is received at the same station:

U. S. S. COLUMBIA,
At sea, Lat. 40° 35′ N., Long. 68° 34′ W.,
4.40 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

After sending message at 3.00 P. M. to-day, I steamed ahead to avoid enemy's cruisers and lost sight of fleet; but later I slowed engines, and fleet has just been sighted from aloft on bearing E. ½ N. (mag.) Fleet is still steering about West (mag.) to S'd of New South Shoal Lt. Sh., and making about eight or nine knots. Fleet is large, and has kept same general course since passing Cape Sable.

COMMANDING OFFICER.

and at 7.30 P. M. the following message is received at Chatham:

U. S. S. RALEIGH,
At sea, Lat. 40° 30′ N., Long. 68° 50′ W.,
5.40 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have again picked up enemy's fleet on bearing E. S. E. (mag.), and it is steering about West (mag.), to the S'd of New South Shoal Lt. Sh., making eight or nine knots. Fleet seems to have between fifteen and twenty ships, and has been making course West (mag.) since I sighted them at 11.30 A. M. to-day. I will keep in touch with fleet until dark if permitted to do so by the cruisers. The evident intention is to make an attack on Newport or Long Island Sound at daylight to-morrow.

COMMANDING OFFICER.

The above message is telegraphed to all points on the coast and full preparations are made to resist the attack. The Northern fleet is informed, by despatch vessels, of the enemy's movements; and the Montauk Point signal station is telegraphed to signal the information to the Southern fleet upon its arrival.

At 6.35 A. M., June 17, two pigeons arrive at the Newport station, each with the following message:

U. S. S. CINCINNATI,
At sea, Lat. 40° 24′ N., Long. 70° 50′ W.,
5.00 A. M., June 17, 1896.

TO COMMANDANT NEWPORT NAVAL STATION:

Have just (daylight) sighted a large fleet on bearing S. W. by S. (mag.). Fleet is standing in for Newport. Cannot make out number of vessels. I will slowly approach the fleet to learn its strength, and I will run for Newport when chased.

COMMANDING OFFICER.

The Northern fleet gets under way at daylight from anchorage near Block Island, and at 7.45 A. M., when 8′ S. E. by E. of Block Island, it is signaled by a despatch boat and given the above message from the Cincinnati. The message is telegraphed to Montauk Point for the Southern fleet, with orders to cruise off the east end of Long Island, but within easy communication of the Montauk Point signal station.

At about 7 A. M., June 17th, messages, in duplicate, are received at the Chatham and Newport stations from the Columbia and Raleigh, stating that the enemy's fleet had passed about 20 miles to the S'd of New South Shoal lightship, and had laid a course for Newport between 2 and 3 A. M., steaming about 10 knots; and that at daylight the fleet had been sighted in lat. 40°

12′ N., long. 70° 59′ W., heading for Newport, and that Columbia and Raleigh were making for Newport.

At 7.10 A. M., June 17th, three pigeons arrive at the Newport station, each with the following message:

U. S. S. CINCINNATI,
At sea, Lat. 40° 22′ N., Long. 70° 47′ W.,
5.40 A. M., June 17, 1896.

TO COMMANDANT NEWPORT NAVAL STATION:

Enemy's fleet bears S. ½ W. (mag.), distant about seven miles, heading for Newport at speed of about twelve knots. The fleet consists of twenty-three vessels, and, as well as I can make out, are as follows: six battle-ships, five armored cruisers, eight cruisers, and four large torpedo-boats. The present formation is double column, battle-ships leading, with torpedo-boats between main columns. I am making for Newport under full speed, being chased by two cruisers. I have not yet sighted our fleet, but have just sighted a vessel to E'd, off starboard quarter, and it is probably Raleigh making for Newport, as enemy has just sent a cruiser after her. Enemy has just sent torpedo cruisers ahead as scouts.

COMMANDING OFFICER.

This message is telegraphed to the Montauk Point signal station for the Southern fleet, and is immediately sent to the Northern fleet by a twenty-knot despatch vessel; and the fleet is signaled at 8.30 A. M., 15 miles S. E. ½ E. (mag.) of Block Island, just after it has made out the Cincinnati and Raleigh, and has sighted a large amount of smoke to the S'd.

At 7.40 A. M. pigeons arrive from the Raleigh with messages of same general purport as the message from the Cincinnati.

At 8.20 A. M., June 17th, three pigeons arrive at the Newport station, each with the following message from the flagship of the Northern fleet:

U. S. FLAGSHIP KEARSARGE,
8′ S. E. by E. (mag.) of Block Island,
7.50 A. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have just received Cincinnati's message dated five o'clock this morning. Will endeavor to engage the enemy about 26 miles S. by E. (mag.) of Pt. Judith. Send the three monitors, the ram, and torpedo-boats with all speed to join me at that point. Sea smooth—very favorable for monitors and torpedo-boats. Telegraph Montauk Point Signal Station to signal Southern Fleet to join me with all speed at a point 26′ S. by E. (mag.) of Pt. Judith; also send a despatch vessel to communicate with Southern Fleet off Montauk Pt. Have just sighted two vessels. One is probably Cincinnati. She will remain with the Flag.

COMMANDER-IN-CHIEF.

At 10.35 A. M., June 17th, two pigeons arrive at the Newport station, each with the following message:

U. S. FLAGSHIP KEARSARGE,
24′ S. by E. ¼ E. (mag.) of Pt. Judith,
9.45 A. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have just engaged enemy at long range. Torpedo-boats are just arriving and monitors are in sight. Enemy's fleet is composed of seven battle-ships, six armored cruisers, six cruisers, and four torpedo-boats. Telegraph Southern Fleet at Montauk Pt. Signal Station to join me with all speed at this point, if you have not already done so. . Telegraph Boston to send monitors with all speed to take station to the E'd of Phelps Bank, in order to cut off retreat of enemy.

COMMANDER-IN-CHIEF.

At 1.35 P. M., June 17th, the following message, in duplicate, is received at Newport:

U. S. FLAGSHIP KEARSARGE,
26′ S. S. E. (mag.) of Point Judith,
12.50 P. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have closed to 1600 yards, both sides suffering severely. Enemy's losses are: two cruisers and one torpedo-boat sunk, two armored cruisers set afire and disabled, and two battle-ships partially disabled—unable to fire barbette guns. Have just ordered Cincinnati, San Francisco, and Montgomery to attempt to make the Sound. They are disabled and leaking badly, so send tugs to meet them between this point and the Sound, and tow them to New York with all speed. Telegraph New York Navy Yard to have docks ready to receive disabled cruisers. Monitors are doing effective work. Southern Fleet has been sighted. Brooklyn has signaled that she is seriously damaged and unmanageable. Have signaled Detroit to tow Brooklyn beyond the line of fire and to try to make Newport. Send some vessels to her assistance. Take her to New York if possible, and only beach her as the last resort. Have lost one torpedo-boat.

COMMANDER-IN-CHIEF.

In the event of hostilities, many more pigeon messages than those given in the above illustration would be sent, in order to insure the receipt of the important information. The latest message should always repeat in a general way the information contained in the messages that preceded it. If even a few messages would be received in case of actual warfare, the messenger-pigeon service would prove most valuable to the navy. Service of similar value to that given by the pigeons in the above illustration would probably be given in the event of a hostile fleet leaving Havana for an attack on our fleet off Key West, leaving

Esquimault for a raid on Puget Sound ports, or appearing on the Great Lakes.

A messenger-pigeon service could be made very useful to the army by locating stations at important military posts. The most important would be near the Canadian and Mexican frontiers, so that an invading army could keep in communication with its base. Pigeons would be very useful messengers during Indian campaigns, especially when the campaign is in a mountainous country. In all such campaigns the pigeons would be efficient, because they are swift in flight and are not in danger of capture by the enemy. They would thus replace the courier, who is in constant danger of capture, and whose speed over mountain trails is necessarily very slow.

The expense of establishing a messenger-pigeon service for naval purposes would be very small in proportion to its usefulness to the government. It must be remembered, however, that such a service cannot be improvised.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

BLOCKADE IN RELATION TO NAVAL STRATEGY.

By Captain A. T. Mahan, U. S. Navy.

(By permission from the Journal of the Royal United Service Institution.)

The Council of the Royal United Service Institution have done me the honor to ask a paper upon the following thesis: "The naval strategy of the past has been dependent upon power to maintain close blockade of hostile ports. Can such blockade be maintained under present conditions of steam, steel, and torpedo-boats? If not, what modifications are demanded by the circumstances, largely varied, from past wars?"

That this is a question involved in great difficulty, if not obscurity, will be readily admitted by all who have given thought to the conditions, or have had experience of them. No reply can be more than tentative until we have the experience of actual war, or until there is made a more exhaustive attempt, than I think has yet been done, to reproduce all the difficulties—not on one side only, but on both—as well as *all* the careful measures to insure success that would be taken by a man under the actual weight of responsibility. Experiments upon war, in time of peace, have little advantage over a game, unless the effects of danger and of doubt, in inducing caution and precaution, can be represented to an extent that they now rarely are.

Under these circumstances my reply must reduce itself largely to an attempt to compare the conditions of the past with those of the present, in order, not so much to decide myself, as to facilitate a conclusion, whether the change, superficially so great, is really one of kind, or of degree only.

It is allowed on all hands, as an historical fact, that such blockades were instituted and maintained with great rigor and efficacy,

though always subject to the chance of successful evasions, during long periods of the French Revolutionary wars. Under former conditions, often both severe and complicated, the thing was done. The question now proposed is: "Can the same, or an equivalent, system be maintained, under the changed conditions of the present day?"

The fact that the question raised depends upon conditions essentially transient in character—conditions which are of the present, not of the past, nor at all certainly of the future; conditions characteristic of the vessels and of the weapons with which the strife is to be fought, rather than of the unknown regions which may be the theater of war—constitutes a fair presumption that the problem itself is in its nature more tactical than strategic —in the strict sense of the latter word.

It is evident, also, that we must not too lightly assume the methods of former days, however admirably they may have been adapted to the ends then in view, as mere precedents, to be followed unquestioningly in our modern practice. We can only safely reason upon the experiences of the past when we have penetrated to, and laid firm hold upon, the principle, or principles, which received recognition and interpretation in our predecessors' methods. When the latter have stood the searching criticism of experience and analysis, we can confidently assert that they were a valid application, under the conditions of one age, of principles that are probably true at all times, and which we may hope to detect by patient study. But when we have correctly stated the principles, it by no means necessarily follows that the application of them will be the same, or superficially even much like those of previous generations.

There is another caution which I think may wisely be observed, namely, not to assume too easily that our forefathers hit upon methods absolutely certain of success in practice—not liable at times to failure. There are few, if any, characteristics of the utterances which I from time to time hear, or read, on the subject of actual warfare, which impress me more strongly than the constantly recurring tendency to reject any solution of a problem which does not wholly eliminate the element of doubt, of uncertainty, or risk. Instead of frankly recognizing that almost all warlike undertakings present at best but a choice of difficulties—that absolute certainty is unattainable—that the "art" consists,

not in stacking the cards, but, as Napoleon phrased it, in getting the most of the chances on your side—that some risk, not merely of death but of failure, must be undergone—instead of this, people wish so to arrange their programme as to have a perfectly sure thing of it; and when some critic points out, as can so easily be done, that this may happen or that may happen, and it is seen undeniably that it may, then the plan stands condemned. "War," said Napoleon again, "cannot be made without running risks, and it is because my admirals have found out that it can, everything attempted by them has failed." Even had we not that high authority, the experience of the blockade system of the past, which forms the basis of the question proposed for treatment, would show that, however sound in principle was the practice of those days, it was by no means infallible; that it ran great risk of failure from circumstances, sometimes anticipated, sometimes unforeseen; and that such risks, constantly incurred, and indeed inseparable from the conditions, did from time to time cause failure and partial disaster. Most of us will recall Nelson's exaggerated expression, "Nothing ever kept the French fleet in Toulon or Brest when they had a mind to come out"; but this exercised no deterrent effect upon his resolve "never to lose sight of the Toulon fleet." He and the men of those days, whether they analyzed their convictions or not, were of a temper which did not yield under partial defeat. They stuck to a plan which in its accuracy seems almost intuitive, so wanting is it of technical expression, or reasoned statement, in their writings; and, as the principle on which it rested was perfectly sound, and the practice based upon the principle substantially the best available to them, they realized the success which in the great majority of cases will reward a right line of action, consistently followed through the ups and downs of good and evil fortune. As the Scriptures have it, "He that endureth to the end shall be saved."

It behoves us, therefore, to consider, first, what was the principle which found expression in the close blockades of the last century and early years of the present; and here I may remark, in passing, that the very word "close" to a certain extent begs the question, and assumes a power which did not actually always exist for the blockading fleet. Nelson's statement, above quoted, by no means stands alone. "Here we are," wrote Collingwood (I quote from memory), when in charge of the Rochefort block-

ade, "lying to in a heavy gale, ninety miles off shore. I cannot with certainty prevent the enemy slipping out before I return, yet I should be intensely mortified if he succeeded. *The only thing to deter him is the fear that he may fall into our midst.*" These last words are worth remembering, as indicating the doubt that the enemy too must have—that he, too, must run risks—and that, if the fear here suggested were realized, disaster would fall upon his schemes. Many a happy chance has slipped through the fingers of this or that warrior because he did not know the hazards to which his opponent was willingly, or necessarily, exposing himself; and excessive pre-occupation of the mind with one's own risks or difficulties is often the cause that blinds men to such chances. I believe that failure to achieve great results is more often due to anxiety about one's own dangers than to over-confidence and rashness. There is a time for prudence, but there is also a time for daring. "It is better to be alarmed now, as I am," wrote Torrington, "than next summer when the enemy is out." Over-caution in campaign may possibly prevent immediate disaster, but it is equally apt to cause ultimate ruin by failure to utilize opportunity. Nelson's biting comment reaches many more men than the admiral at whom it was first launched: "He is perfectly satisfied that each month passes without any losses on our side."

The two great historical instances of blockades, so called, upon a really extensive scale, and sustained with steady resolve through considerable periods of time, are the blockades of the French military ports by British fleets during the Seven Years' War and the Napoleonic era, and the blockade of the coast of the Southern Confederacy by the United States Navy during the Civil War, 1861-65. The latter, however, was a purely strategic operation, which may be accurately described as a steady and strangling pressure upon the enemy's lines of communication, with the result of producing exhaustion through the failure of necessary resources. It resembled, even in method, the Continental blockades of Napoleon's decrees and of the British Orders in Council; and of their spirit, except that they disregarded existing international law, it was a precise reproduction, in the suppression of trade through an extensive coast line. Owing, however, to the fact that there was practically no hostile navy to be dreaded, no tactical precautions had to be observed by the block-

ading forces. These were, in consequence, loosely distributed over an immense line, without any thought of mutual support, or of danger from an enemy. Never did the cordon system, so sweepingly, yet justly, condemned by sound military writers, when adopted as a defensive plan against a valid enemy, receive a more complete illustration; yet, under the conditions of the time, it was admirably calculated for the particular emergency. The United States vessels had not to think of possible injury to their own coast, or to their distant interests, by the escape of the enemy's ships, except in the depredation upon sea-borne commerce by scattered cruisers. The escape of the latter, in isolated cases, through the blockading line could not be prevented; while to protect the trade threatened by their evasion would have required the detachment of so many vessels as to impair seriously the attainment of the far more important military object of the blockade—a fact worthy of most serious consideration in connection with the present subject; for it justifies the remark, parenthetically, that the vast increase of force necessary to repress damage by vessels that have escaped, over that required to prevent their escape in numbers sufficient to constitute a serious danger, emphasizes forcibly the imperative need of intercepting such escape, if it can be done. It will probably, therefore, be admitted by all, that the blockade of the Southern coast was a purely strategic operation, involving little or no practical difficulty regarding the manner of distributing the several detachments upon their respective, and often petty, scenes of operations.

The case was radically different with the British Navy in the periods 1756-1763 and 1793-1814. Whatever the strategic plan, the consideration of which we will for the moment postpone, the problem which its adoption presented to the British admirals was one essentially tactical, viz., how to dispose their ships before the hostile ports, and how to maintain them there, in such wise as to prevent the unmolested escape of one or more divisions of vessels, which, if once away, might do incalculable harm before traced to the unknown goal for which they were destined. That the usual tactical aim of the French was the exact converse of this is, I believe, generally recognized. Their object was to evade the force stationed before the port, to shun battle, in order to effect a certain injury to the enemy's possessions; or, in rarer cases, to support large combined movements of the land and

sea forces in regions more or less remote. Under such conditions, the duty of the watching fleet, as long as it lasted, was excessively onerous. Not only did it entail a state of uncertainty and prolonged anxiety, indecisive of tangible results, but by far the greater strain fell upon the outside fleet, which was in the position of the defendant and underwent most arduous exposure. For all these reasons, but particularly because it was necessary to end suspense and to bring matters to an issue, the primary hope of the British admirals was not to shut the enemy up in his ports, but to compel him to battle when he came out, or as soon thereafter as practicable. The blockade therefore was to be "close," so far as that word was at all applicable, for this purpose only. It is well known that Nelson, with his clear perception of facts in their mutual relations, emphatically rejected the term "blockade" as applicable to his own operations before Toulon. "On the contrary," said he, "every opportunity has been offered them to put to sea, for it is there we hope to realize the hopes and expectations of our country"; but at the same time he, with equal emphasis, and free use of superlatives, charges his frigate captains, "It is of the utmost importance that the enemy's squadron in Toulon should be most strictly watched, and that I should be made acquainted with their sailing and route with all dispatch."

Accepting this as the real expression of the British aim, which upon the great authority of Nelson we well may, let us now try to weigh the advantages and disadvantages, as compared with the conditions of to-day, under which the British admirals then worked in conducting a plan, the success of which I presume is now generally accepted. For of one thing I think we may be reasonably certain, that the strategic danger, and the strategic aim, of a navy which seeks to close-watch hostile ports, are the same to-day as formerly. Whatever the number of ships needed to watch those in an enemy's port, they are fewer by far than those that will be required to protect the scattered interests imperiled by an enemy's escape. Whatever the difficulty of compelling the enemy to fight near the port, it is less than that of finding him and bringing him to action when he has got far away. Whatever the force within, it is less than it will be when joined to that which may, at or near the same time, escape from another port. Whatever the tactical difficulties involved, the strategic necessities compel a diligent study of how to meet them.

The greatest change in the conditions, I apprehend, is the facility now enjoyed by the inside belligerent of moving at any time, and in any direction; to which, and incident thereto, is to be added the fact that the indications of an intention to move are less open to observation than formerly. Then, with the wind in certain directions, the outside ships could feel perfectly sure that the opponent could not come out; and when a successful sortie had been made, but the escaping division been seen by a look-out frigate, the course steered with reference to the wind prevailing might (or might not) give some clue to the destination. It would be pedantry to cite from the numerous proofs of these statements in the correspondence of the day. The same is not the case now—certainly not in any degree comparable to what then obtained. Unless I mistake, the general opinion of those who have had experience is, that it is impossible to prevent the escape of the inside ships. Not having the experience, I feel very great diffidence in expressing even a partial dissent; but when I observe that the conviction of the difficulty of detecting an escaping enemy does not seem to qualify perceptibly the assurance that the low-lying torpedo-boat will easily find its prey under similar circumstances, it appears to me possible that we have here again an instance of the tendency to see all the difficulties on our own side and the advantages on the other. Still, it does remain true that, unless you can compel the enemy to come out at once, or at least very soon, the choice of time and conditions remains with him. All that can in compensation be said is, that the outside party has the same facilities for judging what is practicable at any moment, as the inside; and that the dispositions of each day and night must be made to correspond to the conditions of weather and other circumstances. A night favorable to the operations of the torpedo-boat will not justify the same arrangements as one where it can with difficulty discover its object, or fire with precision.

The question, therefore, presents various phases, but is it not after all essentially one of look-out? of watching a line more or less long, which the enemy may break through at any point, or at least at several points? Whatever the length of the line, the situation in so far reproduces the essential characteristics of one very familiar in warfare, when one party stands on guard over a long line. This has in the past been variously met. The cordon

system, so well known from the liberality with which it has for some generations been condemned, sprang with all its faults directly from the necessity of guarding in some way a long line. It is true, however, and will no doubt be urged in reply, that there is a most important difference in the fact that, the line being once broken through, the great mobility of a naval force enables it to be off and away for its destination, and possibly to disappear from sight and knowledge, without permitting that gathering of the defendant's masses which may be necessary, before pursuit can be adventured. Here, however, very much will depend upon the length of the line through which evasion may be attempted. In a port with but one entrance this may be greatly contracted, according to the dependence the outside party feels in his own protective measures against surprise, and especially against torpedoes. Such a port would resemble a river, or a mountain chain, with but one practicable passage. In a port with two or more practicable exits the difficulty is increased in proportion to the distance of these apart, and the other hydrographic conditions. Two entrances may do no more than dictate a central position for the outsider's force, or it may compel him to double it. The weather, again, will modify the length of the outside blockading line—the area, that is, of the circle upon whose circumference the battle-ships will lie or move. The inner line, the sentries, must always be close in.

It is unnecessary to insist that the belligerent who proposes to take position off the enemy's ports must possess decisive superiority. This is universally admitted. The outsider has the more difficult task; he is on the defensive; he undergoes more wear and tear. He also, as has been intimated, ought to incur as little delay as possible in concentrating a pursuing body, at the least equal to the party escaping. The only adequate provision for these conditions is greater material force. Moreover, the ships with clean bottoms should always be as numerous—at the very least—as the enemy's ships of the same class within. If track of an evading division is not lost, a very consequential factor in pursuit is likely to be the ship first to give out or to slow down. This is a contingency that cannot be dismissed as improbable. It is just such chances as are continually happening—*l'imprévu qui arrive*. Who, with the experience of summer manœuvres, will say that in a division of six battle-ships and attendant cruisers,

pressed at high speed to shake off pursuit and proceed on a mission—or, on the other hand, to pursue such a force—the risk of a hot journal or some breakdown in machinery need not be taken seriously into account?

Let us, as an example, assume such a division to have run out, and that by clever stratagem or otherwise it has got twenty miles' start—a long start in a stern chase—before the outsiders get on the track. Two of the heavy (or fast) cruisers—look-outs—that should ply in couples between the sentries and the main body, have not lost their touch and are following. It is impossible they should be attacked, for their main body is following; therefore they cannot be shaken off. Assuming equality of speed and luck—and equality at the start must be assumed, unless we are to have problems too hopelessly complicated for discussion—the chance is equal in which squadron a laggard will turn up; but, if the chance happen to the pursued, it is much more serious than it would be to the pursuer, for he must abandon the ship or fight—which, again, means abandon his mission. The pursuer, on the other hand, simply leaves his ship behind and continues pursuit. He certainly would not abandon it, for what has happened to him may next happen to the enemy. Even if it be a battle-ship he has lost, and he therefore is by one inferior, he would not be justified in letting go his grip, and with it the chances which the chapter of accidents may next offer.

It may, however, be urged that this escaping by a whole division is not what will be attempted, but that the inside party will send his ships out separately—on the same or on different nights—with orders to assemble at a given rendezvous. But will he? I at least am not so sure; for if on the one hand there is thus multiplied by six the chance of evasion for each ship, there is also multiplied by six the chance that one will fall in with the whole of the outside squadron. A single battle-ship of the present day is too valuable—in immediate money's worth, in importance to the general operations, and in the length of time required to replace her—to be so daringly, not to say recklessly, risked. The mere capture of one such ship would be no small night's work, equalling, as she would, in tonnage and in intrinsic importance to the operation before her, the five ships taken by Rodney on the 12th of April. I am not disposed to undervalue the advantage of the insider, in that he has the initiative—the advantage pos-

sessed by one who has the choice of time, whose different parties move on a preconcerted plan, for a single, simple object (getting away), over one who cannot distinguish just what is happening, which is the position of the outsider. On the other hand I feel that, in considering the possibility of effectively watching an enemy's port, which is the *rôle* of the outsider, one is likely, from his very point of view, to be over-impressed with its difficulties; and I am inclined to think that, if the problem posed were how best to win through the toils of a much superior and skilfully disposed outside force, imagination would succeed in making a similar vivid picture of the risks of running out—of the things that might happen, and the disastrous consequences that might thereupon ensue. Men will not in war undertake with a light heart, adventures which in summer manœuvres entail no more grievous burden of care than a boy's game of hide and seek. Valuable as are the lessons of mimic warfare, there cannot in it be adequately reproduced the element arising from the sense of imminent danger.

Moreover, it should be remembered that, if the blockade has continued for some time, the escaping ships, despite the advantages otherwise possessed by them (clean bottoms, full coal, etc.) will have to do with vessels that have had nightly experience of embarrassments, which they themselves will be undergoing for the first time; a condition precisely analogous to that lamented by Villeneuve when he wrote, "They have not been exercised in storms"; or, as Nelson wrote of the same occasion, "These gentlemen are not used to the hurricanes, which we have braved for twenty-one months without losing mast or yard." Is any one disposed to reck lightly of the moral effect—that most potent spell—or of the trained dexterity, acquired by the mere habit of doing things in the dark and under difficulties? Evasions, if undertaken at all, will not be on moonlight nights and smooth seas, but under conditions that will, to say the least, favor evasion. The same conditions will also, beyond all doubt in my mind, as far as their special influence extends, favor the familiar outsider rather than the unfamiliar insider.

It is clear that the difficulties of the outsider are multiplied manifold, if once the evading party is wholly lost to sight; hence it follows that the most strenuous efforts must be made not to let him escape without fighting. If I may, without affectation of

pedantry, translate this proposition into technical language, it would read that the strategic necessities of the war demand that the area to be occupied by the outsider's fleet (*i. e.*, before the enemy's ports) be circumscribed to the tract consistent with due precaution against attack, and that there be concentrated upon it such a force as would render escape without fighting impossible. The retort doubtless will be that no one denies this, but that the very question before us is how to prevent the escape. Can any force, however numerous, be so disposed as to prevent a sortie being seen? If seen, can the news of the fact, and the necessary information as to direction taken, and the enemy's force, be so transmitted to the main body of the fleet as to give a probability of the latter intercepting the movement? If once seen, can touch of the enemy be kept? Can any change of direction he may make be also distinctly reported? In short, if such a movement is made and discovered, and touch with it is once gained, can such touch be maintained until daylight, or clear weather, enable eyesight to resume its functions? After that the question becomes one of alternative speed and possible accidents.

This series of questions, I apprehend, really states the problem under consideration. The question of relative speeds is not involved, it only comes into play if the fleets see each other, and one is trying to force action; it is, moreover, perfectly simple, as well as outside our problem. Neither is the relative fighting force primarily involved—the superiority of the outsider in this must be assumed—otherwise his attempt to play his part at all is hopeless. The question is simply one of touch, gained and maintained; of immediate and accurate information, and consequently of correct direction given to the party wishing battle. For this, numbers are primarily necessary. The scouting force of the fleet—its eyes, its cavalry—must be so multiplied, organized, and drilled that it can at one and the same time keep track of an enemy and go back and forth to its own main body. This being effectively done, the superiority of the latter comes into play.

Now, there is in this nothing original—nothing whatsoever. It is a mere re-echo of Nelson's cry—not only before the Nile, but at other times—"More frigates!" As a contribution to the question I was asked to treat, the answer I suggest amounts to no more than this, that it eliminates, in my opinion, all subsidiary and related subjects, and reduces the problem to the one simple,

though great, difficulty in which I conceive it to consist. The maintenance of a close and sustained watch over a hostile port, of which we have two great types in St. Vincent and Cornwallis off Brest, and Nelson, under very different conditions and methods, off Toulon, involves many intricate problems. There are the questions of the aggregate purely fighting force to be kept up, its movements and position and all that pertains to its instant readiness, questions of supply, of reliefs, of repair, of reserve, difficulties consequent upon weather; but all these are separable, in thought at least, from the organization of what I have called the cavalry of the fleet. The admirals of former days found it hard to exaggerate their sense of its importance, but the greater facility of movement accorded by steam certainly does make evasion easier than of old; consequently the look-out force must be more numerous, more swift, more systematically organized and drilled.

To make more than a general suggestion, to propose more than a general solution, to go on to propose classes of vessels, methods of operation, and so forth, would, it seems to me, transgress the proper sphere of an officer foreign to the service he is addressing, and for various reasons. Let me, however, recur to one remark already made. The answer I offer may be wholly unsatisfactory, may be a mere lame and impotent conclusion. I of course think that, carefully worked out, first, as to the tactical disposition most conducive to the end in view, gaining and keeping touch, and thence deducing the classes and relative numbers of the vessels needed for the various lines of the blockade, from the outmost to the innermost, a very adequate plan can be evolved. It would have a general resemblance, doubtless, to the sentries, piquets, and supports, that lie between the main body of an army and the enemy; or, to quote a naval historical instance, to the method of the Brest blockade described by St. Vincent in his letters. But, as I have already remarked, unless the idea is futile—barren—its inadequacy demonstrated by experience or logic, it is not a sufficient reply to show that it may, by this chance or that chance, by this mistake or that mistake, incur failure. If a perfectly sure thing is required, I certainly have none to propose or advocate. Supposing a plan based upon the idea I suggest, or upon any other, the fair question to be asked by one weighing it, is not, "Does this make it impossible for

the enemy to escape?" but, "Does this impose upon him such risks as to give a considerable chance of either stopping or crippling him, if he attempt it?" And not only is this chance in your favor to be considered as to the immediate locality, but also as to its deterrent effect upon the enemy; and, consequently, the impediments raised by it in the way of any great combination, dependent upon the evasion taking place at a particular moment. As I have repeatedly argued in my book upon the Napoleonic wars, it was not the certainty of stopping a particular evasion, but the high probability of frustrating a great combination, that made the distinguishing merit of St. Vincent's system.

The ease of movements both in time and direction, conferred by steam, again intervenes here to exaggerate, in my judgment, both the supposed facility of combinations effected from separated ports, and the assumed consequent danger incurred from them. Sight is lost of qualifying conditions. Men's imaginations, kept in constant activity by the scientific advances and inventions of the day, have developed abnormal agility, and mental pictures are drawn in which fleets get about as though by magic. The movements of modern fleets are in fact extremely hampered, and their scope restricted, by the very elements to which they owe much of their power. Their coal, ammunition, water, and supplies are immensely less, measured in duration of time, than the corresponding factors essential to the efficiency of the old ship of war. Nor are they thus fettered only by causes internal to themselves, but external conditions deprive an evasion of much of its former menace. Squadrons and divisions cannot disappear as completely, nor for so long, not even comparatively to modern conditions, as they formerly did. With a network of cables under the sea to neutral ports, where abide the consular agents of each nation, the need of renewing coal will make a fortnight a long time for a fleet to disappear from the world's knowledge. A fortnight, you will say, will allow much damage to be done. Doubtless, but not vital damage, if the enemy be decently prepared. It is not to be presumed that a maritime nation will allow its vital interests, home or colonial, to be so exposed that a fortnight's gain of time will prove fatal to any one of them; while, as for lesser interests, or smaller injuries, one does not go to war expecting never to get a shin barked or a limb broken.

I think that the consideration of the difficulty of effecting such vital damage will have a further deterrent effect upon the insider —the weaker party—and conspire with that exerted by the outsider's thorough arrangements, to gain and keep touch, to make him very wary and cautious as to what he attempts. Also of course, if the latter accepts Napoleon's dictum that "War cannot be made without running risks," or, as Jomini more strongly puts it, "After all, one goes to war expecting to take risks," he will not abandon plans of offense because there is difficulty in them, or because disaster may ensue upon failure. The weaker must be the more wary and the more cunning; but he should not despair, and should aim to be also the quicker and the more energetic. The outsider may be stronger before each port than the insider; but the detachment before each hostile port can scarcely be as large as the whole of the enemy's navy. The cruise of Admiral Bruix in 1799 is the conspicuous illustration of the opportunities which chance may offer; though it must be remarked that that chance was obtained, not by a mass formed by detachments combining at sea, but by one already gathered in a single port, from which it issued in mass. The intended subsequent combination with the Spaniards proved in fact a failure; it could not be effected, until after the possible offensive purpose of the cruise had been defeated, by the junction of the British divisions. "What a game had Admiral Bruix to play," said St. Vincent; and Nelson afterwards: "Your lordship knows what Admiral Bruix might have done, had he done his duty." The opinion of two such men, then on the spot, stamps beyond question the possibilities offered to the inside party, by chances inseparable from war. The attempt to close hostile ports against evasion is almost imperative upon a nation dependent upon the sea; yet if done less than efficiently—I do not say "absolutely"—it may quite possibly involve greater danger than leaving the ports unwatched, and simply keeping your own fleet massed and in hand, which was Lord Howe's plan.

In conclusion, I should be inclined to summarize the whole question somewhat in the following manner, which will doubtless involve a certain amount of repetition. Using the term "blockade" loosely, as the nearest single word to comprise any close watch over the entrance to an enemy's port, with a view to impede egress or ingress, such blockades are of a twofold character—

offensive and defensive. The first is directed against both egress and ingress, but more especially against ingress, being meant to prevent the entrance of needed supplies, and being therefore essentially a blow at communications. The second also has a twofold aim, but its chief object is to prevent egress unmolested, because such freedom of issue to an enemy means danger, more or less great, to certain national interests; which, because they lie outside the national boundaries, cannot be protected by ordinary defensive measures, by fortifications and organized land forces. Such a blockade is, therefore, essentially defensive. Resort to it implies the existence of great national *external* interests, which are open to injury, and can in no other way be so cheaply, sufficiently, and certainly defended. If the external exposed interests are many, it is impossible to imagine any means of guarding them equal in efficiency to that of heading off danger at its sources. This is the strategic necessity—the decisive strategic consideration, which dictates the method essential to be adopted. Resort to this method implies, besides the external interests, a naval strength so superior as to permit being before each port watched, in force superior to that of the enemy within. This is a simple question of preparation, which, however arduous it may be to the national resources, presents no intellectual problem difficult to be solved. It is a question principally of money, secondarily of preparation, not only adequate in the aggregate, but adequate in the discretion with which that aggregate is apportioned among the various branches of the fleet, based upon a due recognition of the part which each branch will have to play in a proposed blockade. Such antecedent appointment is as really tactical in character as is the disposition of a given force before a given port.

Further, to assign to a given blockade a fleet of battle-ships, superior in any required degree to the inside enemy, presents no problem perplexing to the intellect. The real problem is to assure a reasonable probability that that fleet can bring the enemy to action, if he attempt to come out. This is a matter of look-out, instituted and sustained, and of means of inter-communication between vessels of the blockading force—whether by signals or by hail. This is the crux of the matter, and it is one so intricate and onerous, subject in execution to so many mishaps, that I do not wonder it should seem insoluble. Without due personal experience, I speak with the utmost diffidence, but I believe that

by the employment of extensive means it is possible to attain, not certainty, but that degree of probability which, both in actual result and in its deterrent effect, would largely insure the end in view, the protection, namely, of the external interests of the country. The question involved is the defensive watching of a given front of operations. The system must resemble in general features that of an army similarly engaged. Nearest the enemy the units of force must be small, and their commanders deeply impressed with the sense, not only of the need of quickly gaining and sending information, by whatever means, but also and still more that the safety of their individual commands is as nothing to the performance of the duty assigned. Why, even, should it be thought improbable that a resolute attack upon an issuing force, by the look-out lines, though necessarily inferior, should so embarrass or injure the enemy under the difficulties of night, as to gain time for its own main body to come up—or else might frustrate the movement by the resultant confusion? Certainly it is contemplated, on all hands, that attacks by torpedo-boats from inside will be one of the greatest anxieties of a blockading force; why should it not in a degree concern one trying to run out? In land warfare, inferior force often retards or disquiets movements which it is inadequate to prevent; can no ingenuity figure analogous use of naval force? Many things go to constitute inequality besides physical or material strength—position, opportunity, accident, chance, a happy inspiration. There is nothing in the essential nature of war which makes improbable, under any change of ships or weapons, that there should be repeated the part played by the frigate Penelope, in impeding and ultimately frustrating the escape of the 80-gun ship Guillaume Tell from Malta, in the year 1800. A party whose one aim, for whatsoever reason, is to evade, is sorely hampered in its endeavors to shake off even a much inferior foe. The fear of the delay entailed may prevent it from resorting to measures which, under other circumstances, would soon crush the petty intruder.

In short, to summarize once more in a sentence, the question—the old question and the new alike—is not, "Can any enemy be prevented from coming out?" but, "If he does, can touch with him be gained and preserved?" Steam, in my opinion, has simply widened the question, not changed its nature. I believe that provision can be made which will give a high probability of success, but I do not believe in certainties in war.

DISCUSSION.

The Disappearing Gun Afloat.* (See No. 75.)

Chas. H. Cramp, Esq.—From an examination as exhaustive as the limited time would permit, the report on "The Disappearing Gun Afloat" seems to cover all points involved in the particular scheme which formed its subject-matter, and to that extent is perfect.

There can, in my opinion, be no question as to the advantage of the disappearing system in naval gun-mounts, provided mechanical devices can be found to operate it efficiently and reliably within the necessary limitations of weight and space. The system itself is by no means new, having been, as is pointed out, employed by the English in the Temeraire nearly 20 years ago, and by the Russians in the Catharine II, Tchesme, and Sinope ten years ago. The types differ in detail, but not in principle; both being hydraulic and both involving trunnioned guns working on levers; bell-crank in the case of the Temeraire and straight in the Russian ships. King, in his "War Ships and Navies of the World," published about 15 years ago, reports that the performance of the Rendel system in the Temeraire was satisfactory, but he does not describe the conditions of trial. The Russians did not publish the performance of their ships, but so far as I can learn, the Moncrieff system in use in the three battle-ships of the Black Sea fleet has functioned well in smooth water. I have no data as to any performance when the ship was rolling.

This brings me to remark that the principal, and possibly insurmountable, mechanical difficulty in adapting any disappearing system to all-around naval use, irrespective of sea conditions, is that of assuring proper function of the mechanism in all the different planes presented by a ship's motion in a sea-way. Any properly designed and constructed disappearing gun-carriage will operate well when the line of recoil is perpendicular to the plane of a fixed base, as in shore mounts. But I do not know of any device which would insure proper action of the supporting levers and the mechanism controlling them when the gun is fired, say directly forward with the ship at an angle of heel such as to throw a preponderating weight on one lever. It has been suggested that heavy guides in arc form might be fitted to take the sidewise thrust in such cases, but until such a device shall have been worked out and tried no reliable opinion can be formed as to its adequacy.

The scheme which forms the basis of the report contemplates the disappearance of the gun, shield and all, on a line perpendicular to the keel, into a barbette. This would necessarily involve a barbette of

* Further discussion on the subject-matter of this paper is requested.—Ed.

inside diameter equal to the length of the gun, besides suitable clearance, in order that the disappearance might occur at any angle of train. The 13-inch gun, for example, would require an interior diameter of something more than 40 feet in the barbette for a single gun, and about 48 feet for two guns if mounted with as much space between them as the Indiana's are. Thus the designer would be at once confronted with a most formidable weight problem in the amount of armor required for a barbette of such dimensions.

But granting that the weight problem of the enormous barbette could be solved, the architect would straightway encounter another one not less difficult, namely, that of providing for the disappearance and re-lifting of the gun or guns with mounts, turntable and shield, not only with the ship on an even keel, but also at any angle within her arc of rolling. I will not attempt to analyze the mechanical elements of this latter problem here. But it should be observed that the majority of men who conceive schemes in a general way take no thought of the problems of applied mechanics involved in their practical execution. In fact most of them are incapable of applying mechanical practice to the solution of any problem or to the execution of any scheme. They simply think or imagine or dream of something and then expect the practical mechanic to effectuate it.

I have given some attention to the subject of disappearing naval mounts for heavy guns, and the result of my study and calculations in this direction took shape in No. VIII of the schemes which I recently submitted to the Navy Department in my bids for battle-ships in Class II, A. I made no attempt, however, to arrange for complete disappearance of the gun or guns. The device elaborated made provision simply for depression of the breech to a certain angle by recoil, to a loading position within a barbette of ordinary dimensions for the caliber of guns involved, leaving the muzzles exposed as usual in all modern mounts, whether of the barbette or turret or shield type. Using the very long guns of the present day, I see no practicable escape from muzzle exposure. Returning to the Temeraire by way of example, it is to be noted that her disappearing guns are the old type of 25-ton muzzle-loaders, and very short in comparison to modern breech-loaders of equal caliber, or even of equal weight. It was therefore comparatively easy to provide a barbette large enough to house such short guns entirely by recoil disappearance. This suggests the idea that, perhaps, in battle-ships destined to fight at the closest quarters the length of even modern breech-loaders might be reduced without detriment to their real battle-power.

In conclusion I will say that while I think I have worked out a practicable plan of semi-disappearance or breech-depression to a point of mechanical satisfaction at which I was willing to submit it as a scheme accompanying a bid, I am yet not wholly without misgiving about it, and am not altogether prepared to recommend any disappearing system for naval gun-mounts in competition with any tried and proved system of fixed mounts, whether in turrets, barbettes or shields.

WILLIAM CROZIER.* Captain of Ordnance, U. S. Army.—The valuable action of a disappearing gun upon shore is that it drops, upon discharge or very soon thereafter, from an exposed position to one of greater security below. To compass this action, the only features about which military engineers have given themselves much concern have been those connected with the means of raising and lowering the gun. The elements of the security which is enjoyed in the lowered position, viz., a greater or less degree of invisibility and invulnerability, are so easy of attainment that they have been taken for granted without, thus far, any indication that too little concern has been felt in regard to them. But afloat the matter is very different; the mere statement why a lower position should be more nearly impenetrable or much less visible than a higher one, unless the lower position should be below the water-line, is not simple, and the complexity of the question as to the desirability at all of the disappearing principle afloat has been abundantly shown by the multitude of considerations which have been brought to bear in the able paper under discussion.

It may be assumed, from the experience had on shore, that if the secure lower position be provided, efficient means for dropping the gun into it will be forthcoming, although there may be room for difference of opinion as to the character of these means, particularly as to the relative merits of the general systems of the rocking lever and the vertical ram, to which I will allude briefly later. It is not for me, in my ignorance of naval construction, to indicate how a secure low position for the gun on board ship may be attained; but to criticise is much easier than to create, and to indicate the unsatisfactory envisagement of the question I will examine cursorily the sketch design of disappearing turret shown in Fig. 17, which the author presents as indicating, in a very general way, the plan which he has been led to regard as most feasible.

Considering the gun in the lowered position, suppose that portion of the armor plating of the fixed turret which is above the lower edge of the hood over the gun to be removed and distributed over the conical surface of the hood, increasing the thickness of the light armor of which the hood is formed; the protection in the lowered position is increased because, the surface of the turret removed being greater than the conical surface of the hood, the armor when applied to the latter surface will be thicker. If now we mount the fixed turret upon rollers, attach the gun and its carriage to it and suppress the lifting ram, we are back with our old friend the ordinary turret, having secured by the change constant protection slightly greater than that afforded by the disappearing turret to the gun in the lowered position and much greater than is afforded to it in the firing position; a saving of the weight and the complexity of the lifting mechanism, and an increased rapidity of fire by avoidance of the necessity for traversing to the lowering position, lowering, raising and traversing to the firing position. To offset these gains I cannot see that there has been any

* Joint inventor and designer of the Buffington-Crozier system of disappearing gun mount.

sacrifice unless it be the less command of the gun than when in the firing position. But as the disappearing principle has not been mentioned as a means for obtaining increased command, I am not considering it with reference to that object.

The estimated rate of fire with the disappearing turret would require a high degree of perfection for its attainment. In a recent trial of the gun-lift battery at Fort Hancock, upon which are mounted two 12-inch guns having a vertical rise and fall of about 14 feet, produced by hydraulic ram mechanism, the rate of fire was one round per gun in something over eight minutes, the time required for raising or lowering, considered separately, being 15 seconds. As all hands engaged, though understanding their duties, were entirely without drill, the rate could probably be increased to one round per gun in about 6½ minutes. With the estimated rate the author makes it plain that the advantage of ability to fire over a lowered turret is probably more than offset by the diminished rate of fire. This probability becomes, I think, certainty in view of the results at Fort Hancock.

I have no data of the firing of a gun of as large caliber as 12 inches from a carriage of the rocking lever system, but a reasonably accurate estimate of the rate can be formed from the performance of guns of smaller caliber. An 8-inch gun was fired ten rounds at Sandy Hook from a Buffington-Crozier disappearing carriage at the rate of one round every 1.35 minutes, and a 10-inch gun from a carriage of the same type at the rate of one round every 1.67 minutes, the ratio of the rates being 1 : 1.235. The weights of the gun, projectile and charge for the 10-inch gun are about double those for the 8-inch. The weights for the 12-inch gun are about 1.75 times those for the 10-inch, so that the ratio of the rates of fire of the two, based upon these elements, should be somewhat less than for the 8 and 10-inch above stated, so that if, on the contrary, we increase the ratio to 1 : 1.5, we should not be overrating the 12-inch gun. The latter ratio would give a rate for this gun of one round every 2½ minutes. This is so much greater than the rate indicated by the experience at Fort Hancock for guns mounted upon vertically moving lifts as to probably more than offset the exposure due to the necessary final aiming of the gun when in the exposed position.

To a landsman the type of vessel upon which disappearing guns could be used to advantage would appear to require the following:

A complete belt of armor at least as efficient as is now provided, a central armored citadel, the lower edge of the armor joining on to the belt, and carried up as high as the available displacement would permit; guns of the primary battery mounted within the citadel upon disappearing carriages of the rocking lever system. These requirements would seem to leave latitude to the naval constructor in regard to the use of armored decks, building up the ends, disposition of the secondary battery, and so forth. The type seems to come out very much that of the Russian Catherine II, but it may be stated that with a rocking lever carriage a drop of 6 feet for a 10-inch gun would be a very

moderate requirement, and the 4 feet given by Messrs. Easton and Anderson to the 12-inch guns of the Catherine II seems altogether inadequate.

It is with great diffidence that these remarks are advanced. The subject is one of such difficulty that no one unfamiliar with naval construction is in a position to deal with it.

J. E. COMPTON BRACEBRIDGE,* Captain Third Middlesex Volunteer Artillery.—I am afraid the questions under discussion are to be dealt with rather by the naval architect than by the gun-mounting manufacturer, but I personally do not think that disappearing turrets can be made use of on board ship. The mechanical difficulties are very great, and are increased by the long chases of modern guns, and the advantages are rather dubious. So far as we know, the mountings of the Russian ironclads have worked well. The great disadvantage of disappearing mountings on board ship is the exposure to plunging fire. No system of shutters for the hole through which the gun goes has been worked out, and they would be very liable to jam if struck. I was much struck by the remark as to the fondness of even a Japanese blue-jacket for a good upstanding target. It reminded me of the naval officer who announced that he intended on going into action to paint his conning tower bright scarlet and work the ship from the roof of the turret.

J. H. GLENNON, Lieutenant, U. S. Navy.—Leaving aside the question proper of the "disappearing gun afloat," which certainly does not at all simplify the already sufficiently complicated and delicate mechanisms of battle-ships—and simplification is the direction in which we are compelled to look—let us consider a little more closely one or more of Mr. Hobson's statements.

On page 631 we read: "To advance towards the equality of protection that would produce the highest resultant efficiency of the vessel, toward the infliction of the maximum amount of injury under the conditions for which designed, toward arriving under such intended conditions of engagements at the desired point where the offensive and defensive power would disappear together, when the last of the personnel and secondary battery would be destroyed, the vitals pierced, uprightness undermined, and the last heavy turret gun disabled at the moment that the vessel foundered, capsizing as the last vestige of buoyancy went under; to advance toward this ideal combination it would be more advantageous to expand effort available for protection in increasing the protection of the elements enumerated rather than in increasing the protection of the heavy turret guns."

This is a statement in some detail, plausible enough of course; in fact it belongs to a class of statements which we generally accept as incontrovertible. But inasmuch as it is given as the basis of a scheme

*Expert for Easton, Anderson & Goolden Ltd., London, builders of disappearing mounts on the Russian battle-ships.

for armoring ships, we should look at it in some detail. Diminish the turret armor, increase by the same total weight the water-line armor, cease firing and slow down, allowing the enemy calmly and without excitement to approach closely, and three shots will do the whole thing, that is, effect the destructive combination quoted above. Battles on land seem to indicate that when seven per cent. of an army are killed it is time to retreat. I believe this was the rate at Waterloo, being nearly double that at Gettysburg. After the battles of seven per cent. we come by a sudden jump to those of approximately 100 per cent. like Cannae. This indicates to me that when about one man in 13 is killed a panic seizes on the others, and they are no longer of much value for fighting purposes. The element of human nature must be more fully considered. It seems to me evident that the above 7 per cent., or the panic stage, whatever that may be, should be coincident with the loss of stability and buoyancy, simply from the view of their protection alone. But we must not consider their protection alone.

It is impracticable to armor the sides and bottom of a ship sufficiently to keep out all the projectiles which will be brought against it, or even to approach closely this proper thickness necessary to protection of buoyancy and stability. An inch of armor taken from the side would mean several inches to the turrets with absolute security there. The increased value to the offense, in view of security, would alone probably be the equivalent, as a defense, to the inch of armor on the side, not to mention the saving of personnel and gun mechanisms as a desideratum. In other words, the men themselves and the guns are the equivalent defensively of so much side armor, and as they are destroyed, we must imagine layers of the side armor to be dropped off. All this is as regards guns alone. When we come to consider torpedoes, the fact of the security of the personnel and gun offense has much greater value than the side armor, for that of the latter is nil; offense, here the destruction of the torpedo while still on board the enemy, and the consequent restraint due to objection to being "hoist with one's own petard," being the principal, if not sole, defense. I will not go into the subject of the ram, as it is too intricate. The mind that guides the ram should certainly not be "rattled" or have arrived at the panic stage.

I am happy to say that in most of the other parts of his essay I agree with the writer; and I would like to compliment him, if permitted, upon the thorough analytical way in which he handles his subject.

G. W. VAN HOOSE, Esq.—The official report made by Assistant Naval Constructor Richmond P. Hobson on the model with disappearing turrets, which was presented to the Navy Department by myself, contains many suggestions and observations which are far-reaching in their consequences.

This report is divided into two general classifications:

First. A discussion upon the model and the proposed plan.

Second. A general discussion upon certain features of the present type of warships.

This last-mentioned branch of the subject, in my judgment, is as full of general interest to the student of naval warfare as the first would naturally be to myself.

This part of the report also clearly shows that Mr. Hobson is a practical thinker, and has been asking himself the grave question: What will the present type of warship do under a prolonged and heavy fire? He clearly thinks that the ship will, under many conditions, capsize and sink, with perhaps most of its turrets in good working order, and he demonstrates his conclusions in a most unanswerable manner.

In my judgment, a careful study of this feature of the report will repay any friend of the Navy, even if he does not believe as yet in the proposed new departure.

The writer of this article does not belong to the class of persons who see nothing good in the new Navy, but he recognizes the fact that the genius of America has begun to take hold of the great problem of the coming warship; and such creations as the Indiana, Iowa, New York, and similar types, reflect great and lasting credit upon their designers.

The model which was submitted to the Navy Department and referred to the Bureau of Construction and Repair, and which was most carefully studied and considered by the author of this report, was not submitted with the idea that it illustrated any fixed or even accurate plan. It was only intended to be illustrative and show in a general form a certain plan, which could be modified or changed to suit different types of warships.

A kind and courteous invitation had been extended to me to contribute an article upon this subject, but the time was so short that I could furnish nothing better than the following short reply, which had heretofore been filed in the Navy Department, and which explains my plan in certain matters of detail. Taking this in connection with the printed official report will fairly show the proposed system. After a most careful consideration, the Patent Office Department allowed the writer all his specifications and claims, thus confirming the statement of Mr. Hobson that the main idea was novel.

In reply to Report No. 5801, made by the Bureau of Construction and Repair, I wish to file a short statement in explanation of some matters of detail relating to my model of a warship.

The military tops or masts shown by the model are not intended to represent the tall military masts of the present battle-ship or cruiser. It is utterly impossible to raise or lower such masts, and I did not intend to suggest this mechanical impossibility. I only intend to raise and lower a circular platform as suggested by the report. This could be raised by means of hydraulic, pneumatic or pulley power. The model is intended to suggest a top which can be run up at critical moments a distance of 25 to 35 feet. The report concedes this to be a valuable idea. I believe that several of these military tops can be used to great

advantage. They can be located in many parts of the ship without interference with the machinery below the water-line. The machine guns in these tops can also be fired from the upper deck in many positions of the ship. The model also indicates a number of strong girders extending above and across the upper deck. This formation is intended to support a developed platform, which will carry the search-lights and a number of rapid-firing guns to repel the attacks of torpedoes. It is intended that these girders should be strongly braced and connected, so that some of them can be destroyed by shot without undermining the superstructure. Its open framework will permit shot and shell to pass through it in many cases.

It would be perhaps advisable in a close and heavy fire to withdraw the men from this upper platform during its continuance, but the probabilities are great that enough of the guns will survive to enable them to be used to great advantage at some critical moment.

The model was made to illustrate a large battle-ship, but this was only illustrative. The system can be applied equally as well to coast-line battle-ships, or a special type of low freeboard coast-defense vessel.

I believe a low freeboard could be used to great advantage for river and harbor defense. The number and caliber of the guns would have to be proportioned to the tonnage of the craft.

The report seems to state that this system would *per se* cause the hull to receive greater punishment. I cannot agree to this as a mechanical necessity due to the system. I believe that it will be admitted that at moderate range most projectiles are fired high by inexperienced gunners, and that the upper works, such as smoke-stacks, masts, military tops, etc., will receive a great number of hits, but I cannot see how elevating the guns so as to invite fire on them will save the hull, if the enemy's crew are veterans and will aim at the weak parts of the ship.

The report, however, does point out with great ability the weakness of the protection to the hull, as compared with the turret, on the present type of ship.

My whole system is based in a great measure upon this idea. Armor 18 inches thick on the turrets cannot save the unprotected hull. The model is intended in a general way to illustrate a warship which can concentrate a superior fire upon an enemy of its class and overwhelm him with its battery power, and in this manner virtually protect itself.

The guns are not made to disappear simply to protect them. The main idea is to get them out of the way so as to double the battery power.

In my judgment, the whole of the main battery fire of this ship should be aimed at the hull of the enemy. The secondary battery could be aimed at the ports of the turrets.

I wish here to state that the type of ship represented by the model is intended to carry a very heavy secondary battery, but as I had nothing very distinctive to illustrate, I did not show this feature to any great extent on the model. The report, however, treats of this

important feature with great fairness, and it also points out the various ways of arranging a powerful secondary battery.

The report points out certain defects in proportions of scantlings, beams, form of armor protection over the guns, as shown by drawings, etc. I am aware of all these defects, but I only intended to illustrate general ideas, and did not make any claim to professional accuracy on some of the details of the model.

The value of this system will depend upon good mechanism, as the report states; and I confidently claim that hydraulic power can be utilized to lift the weight of the guns and armor to protect them, and that it can be regulated with unfailing accuracy.

The report concedes that the direct lift is the best method of elevating the guns, and this was the only method that I intended to illustrate. No details were specified, for it will be evident that details would have been useless in a mere preliminary exhibition of a new system. However, I promise to bring forward a general plan to lift the guns upon a system which will meet all necessary requirements. I had foreseen that good mechanics would state that certain indispensable conditions existed, namely, strength to resist shock of projectiles, the shock of the guns in firing, the support of the guns while in their elevated position, and a constant supply of ammunition. This can all be done by strong, simple and effective methods. I am willing, however, to admit that expert designers must aid in this work, and I sincerely hope that this system will receive the aid of their learning and ability.

I do not approve of any system of lever lifts, because all such as I have seen leave the guns utterly unprotected, and besides, one set of guns cannot be fired over another set. While the weight lifted by levers is much less, yet this system is worthless in developing increased battery power. My main object is to destroy an enemy in a naval combat, and this must be done by directing upon him a heavier fire than he can return.

Armor will protect the ship where used, but so much of the ship is left unprotected that sea-going vessels will have to do their work quickly, or else the unprotected parts will practically be destroyed.

I anticipated that some naval men would object to giving up the present upper works, but this must be done to gain the great increase in battery power. This great offensive fire is after all the best protection to the ship carrying limited armor.

I believe that my patent points out and covers the field for concentrating upon an enemy a greatly superior fire with the same number of guns. The various ways of lifting the guns are detailed at length in its specifications.

Assistant Naval Constructor HOBSON.—In the valuable and interesting discussions above, the ideas advanced agree with and emphasize the conclusions arrived at in the paper, except in the following cases:

1. Where it is advanced in effect, (1) that the usual form of turret would present advantages over the form of disappearing turret sug-

gested as best fulfilling the conditions, though the latter had perfected mechanism; and (2) that the rocking lever system presents advantages over the vertical lift or simple rise for use on board ship as well as ashore.

2. Where it is advanced in effect (1) that in the existing battle-ships of usual types the hull is better protected than the heavy turret guns; and (2) that the issue of probable engagements will be determined more by injury to the personnel than by the other forms of injury inflicted and sustained. The first two cases affect the disappearing gun proper, the last two involve the broad question of relative protection and the distribution of armor.

I.

1. Turrets, whatever their form, are destined to perform an office for guns whose positions of emplacement are determined or fixed.

To compare two systems of turrets with a view to determining their relative merits, particularly with regard to the question of weight, they should be considered as fulfilling their office for the same guns in the same position. The weight of armor in any system varies directly with the height of the gun above the protective deck. To compare rationally the weight in two different systems this height must therefore be taken the same in both.

In the case sketched in Fig. 17, page 611, the guns must fire at a certain height above the upper deck. The turret shown as fulfilling this condition cannot be compared for weight with one of its own or any other type that leaves the guns below the level of this deck.

Obviously the conversion into the usual turret, referred to for illustration in the discussion, should be made with the guns in the raised, and not in the lowered, position as advanced. The fixed armor, which is the same as the fixed armor in the usual case of barbette or turret, must remain the same. The armor to increase the thickness of the light turret must be additional. The condition of weight becomes the same as set forth in the paper, a small reduction in the weight of additional mechanism, and a heavy increase in the weight of turret armor, a net increase of about 180 tons for two 12-inch turrets. Thus the usual system compared with the disappearing system in the figure referred to, instead of economizing weight as advanced in this discussion, entails a substantial increase.

2. In the lowered position the turret guns are protected by the armor of the barbette, practically equal to that of the movable turret in the ordinary system, increased by the armor of the light turret—equal to about ⅓ this armor—and in addition by their invisibility.

Opposing battle-ships are destined in the course of engagements to come into close proximity with each other, and it is at these critical periods that protection will be overmatched by the weapons. Pointing will require but a short time, and the disappearing guns would be but a short time in the raised position, with the possibility of this time being made to occur more or less when the enemies' guns are not ready for firing; while on the other hand, during the comparatively long

period of loading which may extend, after firing, beyond the period of exposure, they will enjoy the protection of additional armor and invisibility.

In the critical periods of passage at close quarters this additional protection is of precious value. At such short ranges special targets will be selected, and their selection will play an important rôle in the issue, notwithstanding the allusions to the contrary contained in the discussions.

Invisibility, which is clearly the only method of protection practicable for the chases of modern guns, then becomes of enhanced value.

The maximum protection in the proposed system is thus seriously greater than the constant protection of the usual system, and is best available at the most critical moments, when weapons overmatch armor, and fire becomes accurate.

In view of this greater maximum protection afforded by the system, and in view of the fact that the minimum protection, occurring when the guns are in the raised position, overmatches the bulk of attacking weapons, while the time of exposure to weapons by which it is overmatched can be regulated at will to correspond to the probability of being hit, it becomes clear that the mean effective protection of the system is superior to the constant protection of the usual turret, which is overmatched by attacking weapons at critical moments of passage at close quarters and which, on the other hand, by virtue of inordinate weight, overmatches out of all proportion the weapons by which it is liable to be struck at moderate ranges.

Thus, for protection, as for weight, the advantage lies on the side of the proposed system.

3. The time required in the operation of turning to and from the position for lowering, the time for lowering and the time for rising depend on the efficiency of the mechanism. On the supposition of perfected mechanism, this time would bear but a small ratio to the time required for loading operations. Moreover, there is no reason why, after firing, the operation of opening breech, wiping breech plug, sponging powder chamber, and making other preparations for loading, could not take place during the time of turning to the disappearing position and during the lowering process, while at the same time charges and projectiles could be proceeding on their way up from the magazine; indeed, there is no reason why a lodging place could not be provided for charges and projectiles which would always be in readiness at or just below the position for loading; and then the process of loading need not detain the guns in the lowest position unless such detention is desired, for there is no reason why the features of this process could not be carried on during the process of rising and turning to the bearing of the enemy. Further, as set forth in the paper, the guns could be loaded in any bearing while in the raised position.

Thus, on the assumption of perfected mechanism, the disappearing property superposed would be practically independent of the service of the guns, except in the requirement involved by a single position for

disappearing, necessitating turning, a process that is rapid and precise, and that could be rendered to a certain degree automatic if desired; and the time passed in the lowered position, practically or wholly lowered, would be regulated at the will of the mind in charge. When, then, the greater protection of the lowered position were utilized to its greatest extent, the guns descending after each round, and when at the same time the greatest execution with the guns were sought, the lowered position could be made to correspond to the necessarily inert period of the guns, causing but a very small reduction in rapidity of fire.

4. Turret guns mounted in the most advantageous positions on battleships have a dead angle of about 90°.

Nearly the whole of this angle, as pointed out in the paper, is necessitated by the other gun positions, and one of the main objects sought by the disappearing system is the redemption of this dead angle, amounting to nearly a quarter of the horizon. The risks that are liable to be incurred by firing over the positions of guns while below deck are pointed out in the paper, but the difficulty of providing against these risks is by no means of the order of the difficulty involved in the assumption of perfected mechanism for raising and lowering. It is easily conceivable that by the closing of electrical circuits means could be provided for automatically preventing any gun from firing when other guns would be endangered, or more simply for signaling such danger in a manner impossible to escape the notice of the gun captains.

The discussion advancing the ordinary turret against the disappearing system fails to refer to this redemption of the dead angle and consequent increase of the effective angle of fire.

5. In sum, on the assumption of perfected mechanism, the disappearing system presents for heavy guns serious, incontestable advantages, offers a material economy of weight, affords superior protection for which, in effect, the vertical column of armor is rendered telescopic with one or two thicknesses of armor available at will, to correspond to the degree of exposure, and increases substantially the effective angle of fire; while with all these advantages it necessitates but slight, if any, reduction in the rapidity of fire.

6. But the assumption of perfected mechanism is not warranted. Such a mechanism would require, not only a large source and reservoir of energy and a medium of its direct application, but also a transmission of this energy across joints broken by vertical rectilinear movement as well as horizontal rotary movement and its application on the far side of these joints to varied forms of appliances; and further, would exact with all the complexity, accuracy, and delicacy of these mechanisms and these joints great robustness and solidity to withstand the severe strains entailed by the varied movements of the vessel in a seaway and the shock of projectiles in action. The difficulties in the way of perfecting such mechanism are pointed out in the paper and are strongly depicted in the first discussion. Until they are overcome the advantages set forth cannot be considered as belonging to the system,

for, as pointed out, they are rapidly nullified as the mechanism departs from a high state of efficiency.

The assumption that efficient means of dropping a gun into the lowered position, and by inference of raising it again, would be "forthcoming" was made perhaps without consideration of the feature of raising and lowering armor with the gun, and of the limit of space imposed when a barbette of usual size is employed. The assumption was made probably with a picture in mind representing the simple problem of raising and lowering a gun mounted within a spacious redoubt as on the Russian battle-ships, the disposition afterward suggested as the one best adapted for the use of the disappearing gun afloat.

Reference need only be made to the total lack of cover and the entire exposure to plunging fire, even at small angles, particularly from fire from ahead and astern, to show how uneconomically this vast weight of armor is disposed, the exposure becoming greater as the extent and weight of armor increase. The heavy guns on these battle-ships will probably be disabled partially or wholly by the shower of rapid-fire projectiles, particularly those charged with high explosives, before the enemy comes within the range where the probability of hitting justifies the use of heavy guns. The protection for the guns in these vessels would be far greater if the redoubt were cut and the armor carried around into two barbettes; one enclosing the two forward pairs of guns, the others the after pair; even then it would be most advantageous to make covers or hoods revolving with the guns and having openings for the guns to pass through to protect these enormous barbettes from plunging fire.

The weight of such a barbette, large enough to receive a modern gun entire, would be enormous, as pointed out in another discussion; the two in the case cited amounting to about the weight of the entire redoubt.

Where, however, such an uneconomical disposition of armor is adopted, where such waste of weight is permitted, and where no effort is made to take up protection for the gun and gunner during the time of sighting, a system is readily "forthcoming"; and the lever systems, barring those which employ counterweights, advanced as the most suitable for use afloat, present all the advantages pointed out in the paper. But where armor is economized and a barbette of the usual size is employed, where no attempt is made to protect the robust chase of the gun otherwise than by its invisibility when lowered, where, further, substantial protection is provided for the gun and crew while in the raised position; when, in short, a turret with its guns is to be lowered into and raised from a barbette of but slightly larger diameter, a system is in no sense readily "forthcoming," while any lever system is obviously out of the question. A system of simple vertical rise is the only one possible. Thus far, hydraulics alone can offer any chance of supplying the power under the conditions imposed.

In connection with the comparison of the hydraulic system of simple

rise and the lever system as made in the discussion, it is to be noted that the results of the practical test of the Buffington-Crozier 8-inch mount at Sandy Hook were excellent for time made, though this system of lever mount is precluded from consideration for shipboard use on account of its counterpoise feature which economy of weight prohibits, but it should also be noted that the time required for the rising and falling process for the hydraulic mount tested at Fort Hancock was also excellent, requiring but 15 seconds for each process, which time could of course be very much reduced in the lowering process, and it should be noted further in the comparison that the lift was 14 feet, no doubt double that of the 8-inch gun, and further that there were two 12-inch guns raised together mounted on a single platform, while the estimate for the lever mount was based on the weight of a single gun.

In sum, as set forth in the paper, the system of disappearing turret as embodied in the sketch plan, page 611, offers incontestable advantages, provided the mechanism is efficient; obstacles of a serious nature are confronted in any endeavor to provide efficient mechanism, while the necessity for efficiency is absolute; the conditions impose a simple vertical rise, for which hydraulic power is best adapted.

II.

The permeating object of design in a vessel of war is the realization of a maximum efficiency for each element of weight in its contribution to the ultimate object of enabling the vessel in the probable conditions of service to fulfill the rôle for which it is intended.

The apportionment of the total weight among the features is regulated by the degree of efficiency of weight assigned to each. When finally made, this apportionment should be such that no unit of weight could be transferred from one feature to another with injury to the efficiency of the whole.

The distribution of the weight assigned to a particular feature is governed by the same principle, and when finally determined, the conditions should be such that no element of weight could be transferred from the locality assigned it to another belonging to the feature without injury to the efficiency of the feature as a whole.

The question of the apportionment of weights is not treated in the paper and is not referred to in the discussion. However, assuming the apportionment made, the distribution of the weight assigned to armor protection is intimately involved. It is advanced in the paper that the heavy turret guns are better protected than the features classed together as the hull, and that additional weight and expense, if available for armor, should be assigned to hull protection. It is advanced in the discussion, on the other hand, that in effect the hull is over-protected in comparison with the protection of the guns, and that it would be advantageous to transfer part of the hull armor to the guns. It is further advanced by partial inference that casualties to personnel will constitute the main factor in determining the issue of

engagements, a conclusion not altogether in accord with inferences to be drawn from the conclusions arrived at in the paper and from considerations pointed out below.

It is not necessary for the present purpose to enter at length on the evaluation of the efficiency of the armor weight assigned each feature or element in the usual battle-ship.

In order to arrive at a general conclusion as to the relative protection of the hull and of the guns, and as to the advisability of a different distribution of armor weight, it will suffice to point out simply the salient features involved.

III.

Armor Weight assigned the Guns.

1. The efficiency of any element of armor weight protecting any feature is measured by the demand for protection, resulting from the importance and the vulnerability of the feature, and by the effectiveness of armor in supplying this demand.

2. (1) Every element of offense partakes essentially of the nature of defense from its silencing effect on attacking weapons. In consequence, the quantity representing the importance of the guns should have an enhanced value, a greater exponential weight. But it is to be noted that the silencing effect varies in importance inversely as the degree of armor protection of the enemy's guns, being greatest where protection is least, as in unarmored and unprotected vessels, and in partially protected and unprotected guns, and least where the protection is greatest, as in battle-ships and armored coast-defense vessels, and in heavy turret guns. Thus, though the dual nature of guns is an important consideration, it affects worst the cruiser classes, while on battle-ships it affects most the medium caliber and light guns.

(2) The value of a gun attacking armor passes rapidly from practically zero when the gun is overmatched, to a high maximum when the armor is effectually overmatched. The maximum is practically reached at the present stage of the development of explosives when the gun can drive an explosive projectile through the armor so that its explosion takes place on the inside, which at present may be considered as taking place when the caliber of the gun approaches twice the thickness of armor.

When this point is reached, further increase of caliber is disadvantageous as far as the particular armor is concerned, being advantageous only where there is other armor to be attacked beyond the first armor.

When the armament of a battle-ship has been determined by this principle, and a developed battery is carried that overmatches the light armor of the usual battle-ship in the sense of being able to drive a semi-armor-piercing projectile whole through it, then such a battery, without diminishing the value of the heavy guns, must be ranked alongside of them in first importance, in view of the vast area of light side armor now carried and the grave features it protects. It follows, then, that such a battery should receive an equal consideration with the heavy guns in determining the distribution of armor.

It is interesting at this point to note that the principle above enunciated is followed only in the case of our three battle-ships of the Indiana class, though with these vessels it cannot be said that the principle is wholly carried out on account of the armor for protecting the 8-inch guns not being proportioned to their importance, being of insufficient thickness, and not extending to the casemate armor; while our other three battle-ships, the Iowa, and the Kearsarge, and Kentucky, attain, after the Indiana class, a nearer approximation than any other vessels built, building, or designed.

The Iowa falls short on account of the caliber of her heavy guns, 12-inch, not outclassing the usual heavy armor whose thickness is designed in view of this caliber; though, on the other hand, the 8-inch battery, with barbette armor extending to the level of the casemate armor, approaches nearer the required degree of protection, while the Kentucky and Kearsarge fall short in having but two 8-inch turrets instead of four, and having these hampered in their independence of action; though, on the other hand, an increased thickness has been given the armor protecting these guns, making their protection accord more nearly than in the other vessels with their importance. It should not, of course, be lost sight of that these last two vessels have superposed a more developed rapid-fire battery which would be very effective if vessels of the cruiser classes came within range in a general engagement where the silencing effect of this battery could be effectively employed. The Iowa approaches very near to being an ideal flagship for a fleet of the Indiana class; she would be an ideal battle-ship as far as battery is concerned if her 12-inch guns were 13-inch, and the thickness of armor on the 8-inch turrets were increased 3 inches. To make the Kearsarge and Kentucky approach the same ideal it would be necessary to add two more 8-inch turrets, one on each waist, completing a lozenge. In both cases there would have to be an increase of displacement and cost, though, if necessary, about ⅛ of the 5-inch battery of the latter vessels could be sacrificed to furnish part of the weight.

It is of further interest to note that the system of hull armor now adopted in English construction, studied on the Renown and developed on the Majestic class, is an effectual reply to the semi-armor-piercing projectiles, referred to as influencing the thickness of armor.

The 8-inch gun is overmatched entirely, and heavy guns can penetrate only with armor-piercing projectiles, whose destructive effect is not comparable with the destructive effect of explosive projectiles.

This veritable fleet of battle-ships, created at one call to the English nation, of themselves alone exceeding by ⅛ the number of all our battle-ships yet authorized, is comparatively invulnerable, and will remain so till a semi-armor-piercing projectile can be counted on to pass whole through 9 inches of armor.

Returning to the point established above, the heavy guns in an armament designed for use against all systems of armor now existing, except the one referred to above, now adopted in England, shares the

first importance with the guns of next lower caliber, and should share with them the first consideration in assignment of armor weight.

3. (1) The mechanism, supports, communications, personnel, and other accessories of the heavy guns are of great innate frailty for resisting the attack of weapons and demand an absolute protection. This demand, however, is fully met by the barbette or fixed armor as far as its protection extends.

(2) The vulnerability of the gun proper is small, and as far as its protection alone is concerned the protection of heavy armor as carried in the usual turret is altogether inordinate.

(3) If the personnel, mechanism, and accessories could be abstracted from the gun and could be placed and could remain below the level of the barbette, while an armored hood or cover, revolving with the gun platform, covered the top of the barbette, then the demand for a revolving turret would not exist, provided the breech plug and its vicinity could be protected during the operation of loading by having the breech sink below the level of the barbette cover, as provided for in the most interesting semi-disappearing gun-mounts referred to in the discussion as submitted in one set of plans proposed in bids for battleships 5 and 6, or by means of vertical hood armor rising over and extending to the rear of the breech, carried by the revolving armored platform forming the cover of the barbette.

In sum, the gun itself is robust and but slightly vulnerable, while its mount and all accessories are frail and very vulnerable. Heavy armor is an absolute necessity for the protection of the latter, but is not required for the former, and in consequence a heavy revolving turret is not necessary if other heavy armor protection is available for the mount and accessories.

(4) For the turret guns of medium caliber the vulnerability is precisely the same as pointed out for the heavy guns.

4. (1) The natural envelope of the supports and accessories of turret guns is a vertical cylinder of moderate diameter of section.

(2) A vertical cylinder lends itself most advantageously for the application of armor, for it presents as a projected target a mean angle of impact of large obliquity, while its form is self-sustaining.

The armor applied to the protection of the heavy guns is thus most effective, presenting its face obliquely and sustaining itself by its inertia and the support of its own parts.

(3) The same observation applies with even greater force to the armor of turret guns of medium caliber.

5. Thus, in sum, in evaluating the degree of efficiency of armor weight assigned to the protection of the guns, the following facts are to be considered:

(1) For the barbette or fixed armor, the demand for the protection it affords is absolute, nothing but armor protection is available, and armor applied is effective; in consequence, armor weight applied to such barbettes or fixed turrets has a high degree of efficiency. In the case of heavy guns, the thickness of barbette usually adopted is sufficient,

outmatching the heaviest calibered guns, and, in consequence, but slight advantage would be gained by increasing the thickness, while decreasing it would incur disadvantage.

In the case of medium caliber guns which overmatch light armor, this barbette in usual cases is insufficient in thickness, in some cases does not extend to the protective deck, in others is altogether lacking. The protection of such guns is not commensurate with their importance, their vulnerability, and the effectiveness of armor so applied.

(2) For the turret proper or revolving armor there is but slight demand for its protection from the gun proper; and for the accessories and personnel, which require such protection, it is possible to make other provision in the case of the heavy guns, though this is impracticable in the case of medium caliber guns, whose mechanism is grouped in close proximity to the gun itself.

Where, however, the heavy turret is employed, it is to be observed that the vulnerability of the accessories grouped near the gun is less than that of those below in the barbette, the personnel accessory being capable of relief, being replaced when injured. The thickness of armor employed, somewhat greater in usual cases than the thickness of the barbette armor, is not well proportioned to the demand for protection. It should be observed, however, that as long as any such turret is retained there should be an endeavor to place the accessories below in the barbette as much as practicable, and to dispose them in such a manner as to be the least vulnerable when retained in the turret; but even then the thickness should never be reduced, in a vessel expected to engage at close quarters, below the figure which gives perfect immunity from the penetration whole of any explosive projectile, or below the figure which excludes under all conditions all projectiles from guns other than the heaviest, not considering, of course, the case of a turret that has recourse, when needed, to the protection of the barbette and of invisibility. For a design at the present moment 10 inches would be such a minimum, this being a safe figure probably for some time to come.

On the other hand, with the medium caliber guns destined to overmatch light armor, carrying the vulnerable accessory more with the gun, the thickness of armor is insufficient, and as in the case of the barbette, is not properly proportioned to the importance and vulnerability of the guns and the effectiveness of armor applied to them.

In sum, a high degree of efficiency is enjoyed by the weight assigned to the barbettes for heavy guns, but a lower degree only belongs to the revolving turrets proper. A high degree belongs to the armor weight assigned for both barbettes and turrets for medium caliber guns, but the quantity of weight is insufficient.

There would be advantage in reducing the weight assigned to the heavy turrets and in increasing the weight of armor assigned the medium caliber guns.

As concluded in the paper, there would be no adequate advantage in increasing the weight of heavy turret armor, though there would be

advantage in increasing the protection of the guns taken as a whole, this increase taking the form of increasing the protection of the medium caliber guns, which latter question is not treated in the paper.

IV.

Armor Weight assigned the Hull.

1. The great importance of the features protected by hull armor need not be entered into, being apparent. It will suffice to point out that the integrity of each one of these features, floatability, stability and uprightness, and vitals, is essential, not only to the use of the guns, but also to the use of the torpedo and ram, to the very existence of the vessel.

2. (1) The vulnerability of the features of floatability, stability, and uprightness is set forth in the paper, and not being questioned in the discussion, need not be entered into again. It will suffice to recall that the portion of the hull through which the enemy of all these features, the great enemy of all hollow floating bodies, the ever ready water, may enter has but a fraction of its area covered by armor. It will suffice to recall that but a fraction of the hull liable to alternate immersion and emersion is covered by armor, that vast areas are at the mercy of projectiles and fragments of all kinds, which coursing along the side can cut open long gashes, or flying outboard tear off whole lengths of plating, laying the wall open to the entrance of water, while the portion with armor is but partially exempt.

(2) But the vulnerability of the most important of all features, the vitals, should be looked at more closely. These comprise the organs of locomotion and explosive objects, including compressed gases as well as explosives proper.

The nature of all of these objects is most delicate, most susceptible to derangement that would cost the ship its existence; their protection, if possible, should therefore be absolute. In their position below the protective deck they are liable to injury from above and from the sides.

Wherever a deck, however heavily armored, can be reached by explosive projectiles it is liable to disruption, and it can be laid down as a principle for the present stage of naval progress that when a protective deck worked near the water-line can be reached by a projectile entering at an angle of fall of 7° from any bearing without first encountering armor, or where the side armor above it is outclassed by semi-armor-piercing projectiles, or where the side armor below it is outclassed by armor-piercing projectiles, then an armored deck must be worked below it; and inversely, where there is no armored deck worked below the protective deck situated near the water-line, armor must be placed so as to intercept a projectile entering at an angle of 7° from any bearing before it can reach this deck, and the side armor above this deck must outclass all semi-armor-piercing projectiles, and the side armor below this deck must outclass armor piercing projectiles, or else

the protective deck must descend at sides to the lower edge of this armor.

The first conditions are fulfilled only by the five latest French battle-ships, now building, the Masséna, Bouvet, Charlemagne, St. Louis, and Gaulois; the last conditions are fulfilled only by the nine latest English battle-ships, the Majestic class.

In all other vessels yet built or designed, including all of our own battle-ships, there is no armored deck below the protective deck, and at the same time the light side armor is outclassed by semi-armor-piercing projectiles, which are thus liable to reach the protective deck and explode in contact with it and hurl fragments below into the fragile or dangerous vitals, while the protective deck is exposed further in a greater or less degree to the explosion in contact of projectiles entering above the light side armor, particularly from bow and quarter bearings on which the turrets would not be encountered, and such explosion would blast the deck in the region, likewise hurling fragments on the dangerous mission into the vitals.

It is interesting to note that the disposition on the French vessels referred to, which were the first designs to fulfill the conditions above which provide for a lower armored deck at the level of the lower edge of armor, will provide greater security for the vitals, though it will admit greater internal destruction above, while the disposition adopted in the English vessels, though giving a less guarantee for the vitals, will reduce to a very great degree the internal destruction by excluding all explosive projectiles, by the uniform thickness, 9 inches of side armor.

The fact should be taken account of, however, that development is rapid along the line of explosive projectiles, while the life of a vessel of war is long.

The day is probably not very far distant when 9 inches of armor will be overmatched by semi-armor-piercing projectiles, while there is certainly progress already for the penetration of armor by projectiles carrying high explosives. The English disposition, though perhaps offering better advantages for to-day, will tend to become obsolete, while the French disposition is good for all time.

Thus, in all vessels, with the exceptions above enumerated, the vitals are seriously menaced from above.

But their exposure is not limited to this direction alone. It was pointed out in the paper that the lower edge of armor emerges in the usual cases at an angle of roll below 10°, while the vessels would engage when rolling double that angle. In only a moderate seaway, when the vessel rolls but moderately, or where a wave trough passes along the sides, there will be exposed large unarmored areas below the lower edge of armor abreast the vitals.

In evaluating the time element to which the thickness of armor should in general be proportioned, it is to be remembered that the exposure takes place at the ends of the roll, where the pendulum lingers to reverse its swing, and though in this interval the probability of the

unarmored zone being hit is small for the slowly-firing heavy guns, it is larger for the multitude of smaller calibers in proportion to their number.

Along the vast area of this exposed zone there is no obstruction to impede even the smallest rapid-fire projectile from reaching the magazines and steering engine and gear, while the coal obstruction abreast the boilers and engines is inadequate against rapid-fire projectiles of even reduced calibers. This exposure of the vitals from the sides, which appears in rolling, not infrequently experienced even in the usual sea swell, grows rapidly in seriousness as the sea rises, and in but a moderate fighting seaway becomes by far the greatest menace to the vessel of usual type, whose power of locomotion, whose very existence, stands a free though intermittent target to guns of practically all calibers.

This weakness is an attribute of the battle-ships, built or designed, of all nations. It is less pronounced in those destined to engage in the relatively smooth waters of the Mediterranean. Even for these waters the limit of 4 feet 11 inches set by the French for the desired depth of the lower edge of armor is insufficient, as are also the ameliorations adopted in recent English practice, 5 feet 6 inches in the Royal Sovereign class and 6 feet in the Majestic class, which with larger beam are destined for the high seas. As for our own battle-ships, the designed depths adopted for the lower edge of armor, 4 feet 6 inches in the Indiana class and the Iowa, reduced even to 4 feet for the Kearsarge and Kentucky, are better suited for still water than for the western Atlantic.

Thus the vitals, notwithstanding their careful location below the water-line and below the protective deck, are exposed from above and from below, and being of fragile and dangerous nature, constitute the most vulnerable feature of the usual type of vessel. Thus, for floatability, stability and uprightness, and for vitals, the hull in the usual battle-ship is in the highest degree vulnerable.

3. (1) Each kind or disposition of hull armor, heavy side armor, light side armor, deck armor, must extend over a large area to be effective even in a small degree for the protection of floatability, stability and uprightness, or vitals.

(2) The vertical armor has approximately a plane surface, presented practically normally on certain bearings; it is not self-sustaining, requiring special structural supports, which are of slight efficiency when a shock is received from the inside, an occurrence liable to happen with the light side armor, particularly when the enemy is employing armor-piercing projectiles, which, making but small breaches on the side of entrance, may drive whole armor plates overboard on the other side. The deck armor offers an advantageous oblique angle of impact, but is not supported sufficiently to realize anywhere near its full resisting power.

(3) In sum, the degree of effectiveness of hull armor, spread over large areas and inefficiently disposed, is small in comparison with the degree of effectiveness of turret armor.

4. Thus, in sum, in evaluating the degree of efficiency of armor weight assigned to the protection of the hull, the following facts are to be considered:

(1) The importance of the features protected is commensurate with the importance of the vessel itself.

(2) The vulnerability of the feature is great, and increases as the sea rises, when the demand for protection becomes absolute.

(3) Though subdivision, water-excluding materials and obturating materials are available for the partial protection of floatability, stability and uprightness, features overthrown by the entrance of water, armor alone is available to supplement the sea outside in the protection of the vitals against the violence of missiles.

(4) For protection from injury from above, the vitals demand either an immunity for the protective deck from explosive projectiles, an immunity that can be insured only by an adequate height of side armor of sufficient thickness to exclude explosive projectiles, or else an armored deck below the protective deck.

(5) For protection from injury from the sides the vitals demand, in the case of vessels on the high seas, armor on the sides extending to a greater depth than in any vessel built or designed, a depth in usual cases such that when floating at the designed water-line a roll of 15° should not emerge the lower edge of armor.

(6) The effectiveness of armor weight applied to hull protection is not great, the armor being spread over large areas, which form only a fraction of the areas necessary to be armored to insure security, and the disposition on these areas not furnishing a high degree of efficiency.

(7) Thus, in the case of the hull, the demand for armor protection is absolute, but the meeting of this demand can at best be but partial on account of the ineffectiveness of the armor weight thus employed.

In sum, as advanced in the paper, the hull is but partially protected, and the protection becomes more and more inadequate as the sea rises, notwithstanding the reduction in the number of hits. The demand for protection is great, the feature being of the first importance and in the highest degree vulnerable, but the reduced effectiveness of armor renders the meeting of the demand most difficult, the weight of armor being limited. In the usual vessel this demand is not adequately met, though full weight be given to the difficulty of meeting it, for the vitals in particular lack provision for protection which they must have to enable the vessel to fight securely in a seaway.

Not only should any additional weight available be assigned to providing a lower armor deck and extending the depth of the lower edge of side armor, but armor weight variously distributed in usual vessels in other localities would be more efficient so applied.

V.

Comparing the results arrived at in considering the efficiency of the armor weight assigned the guns and the hull respectively, the following deductions are to be drawn:

1. Due principally to the greater effectiveness of armor applied to turrets, the latter should be to a certain degree more highly protected than the hull.

2. This degree is fully reached by the fixed armor, the barbettes of the usual heavy turret guns; it is overstepped by the revolving armor, the turrets proper of these guns; it is not fully reached for the barbettes and turrets of the medium caliber guns that outmatch light armor. With the proper apportionment among the guns, the protection as a whole would overstep the proper degree of superiority. A surplusage of weight would be available for the hull.

3. The vitals are not protected in due proportion with the usual vessel; another deck should be worked over them and armored, and the sides should be armored to about double the usual depth with reduced and tapering thickness.

The weight for the deck could be partially supplied with advantage by reducing the upper or usual armor deck, and the weight of additional depth of armor could be partially supplied with advantage by reducing by about one-fourth to one-fifth the maximum thickness of the heavy belt and tapering it to 3 inches at the lower edge. The additional weight required should be supplied for the surplusage from the heavy turrets; the insufficiency then remaining should be taken from the upper part of the light side armor, and from battery armor not included in turrets, if additional displacement is not available for armor.

If the draught will not permit of two armored decks over the vitals, then a disposition should be adopted resembling that on the Majestic class, with side armor extending from 10 feet below the water-line at a thickness of 3 inches tapering to a maximum thickness of 10 inches at the water-line and thence to a thickness of 5 inches at a height above the water-line permitted by the weight, with the single protective deck dropped at the sides to 5 or 6 feet below the water-line.

As advanced in the paper, the heavy turret guns are over-protected. Any additional weight available for armor should be applied to the following purposes in the order named: 1st, to increasing the depth of side armor abreast the vitals; 2d, to working a second armored deck over the vitals; 3d, to increasing up to 10 inches the thickness of the turrets of the guns designed to outclass light armor and protecting its supports; 4th, to erecting transverse bulkheads, partial or complete, armored with special hard 2-inch armor to explode high explosive projectiles coming from forward and aft; 5th, to increasing the height of light side armor if already a complete belt, or completing it if incomplete.

It may be added that in the case of existing vessels with insufficient depth of belt and without the second armored deck on which, of course, the above provisions cannot be made, the security can be increased by sacrificing some weight of coal or other feature, and by working a strip of 3-inch armor about 5 feet wide on the wing longitudinal bulkhead on each side of the vessel abreast the magazines, with its top at the level of the lower edge of armor, and by working 2 inches of

armor of the same width abreast the engines and boilers, the same being supplemented by the coal; the armor to be of special hard quality, and due provision to be made for its securings and support; in addition to this, athwartship bulkheads of light hard armor to be worked as described above to prevent high-explosive projectiles from reaching the protection deck.

VI.

1. The discussion which advances the proposition that the guns are under-protected compared with the hull advances also that injury to the personnel will be the principal factor in determining the issue of coming engagements, and that the desired co-ordination of protection should be made in view of a certain panic era of the personnel of the guns' crews, rather than in view of the silencing or destruction of the guns.

The drawing of such conclusions from the examples of history, as done in the discussion, is liable to be found illogical, for when examined closely the conditions existing on board vessels of war will be found radically different from those that existed on the vessels that fought the battles of history. The structure that was then a simple hull with platforms carrying a homogeneous cargo of men and guns with a simple function to perform, is now becoming a complex body filled and ramified with organs and objects of all degrees of power and all degrees of delicacy, performing functions of varied nature and of all degrees of complexity.

The motive power has been transferred from the upper deck to a position below the water-line, and though reducing the number and exposure of the personnel, has introduced a series of delicate and dangerous vitals along a large proportion of the vessel's length.

The open decks have become subdivided, and the once numerous personnel in close contact, having now recourse to mechanical power, has been reduced to less than half its former number and is distributed in small groups almost entirely isolated from each other. In addition, in the case of armored vessels, which constitute the bulk of power whose fate will decide the issue of engagements, the conditions of resistance are radically different. In the battles of the past the projectiles found no objects that could resist them—no places above water they could not enter. Now, the localities containing important elements offer resistance of varying degree. When these localities are confined in extent, as those containing the heavy guns, the resistance is made to overmatch all weapons, and these localities, with but a small fraction of the personnel, concentrate within their security the bulk of the vessel's offensive power.

With these radical differences in conditions it is hardly warranted to draw extensive inferences. It is the utter inadequacy of the past to throw light on the subject that causes the world's imagination to be haunted and the intellects of naval students to be baffled by the phenomena that are to take place when these gigantic creatures, evolved by the nations, meet each other in mortal combat.

It is not necessary for the present purpose to enter at length on this broad subject, particularly in view of the limits of the discussion in question and of the applicability of the conclusions arrived at in the paper and in the reply above. It will suffice in order to arrive at a conclusion as to the part to be played by the casualties to signalize certain additional considerations.

2. (1) A large portion of the personnel is stationed below the protective deck. On the Indiana, whose motive power requiring men below is very moderate compared with the battery power requiring men above, out of a total number of 462 officers and men, 206 are stationed below the protective deck in action. This large portion is abstracted from casualties and is identified with the vitals.

(2) Of the officers and men stationed above the protective deck, the greater part are well protected, the protection increasing with the importance of the function. On the Indiana, out of the 256 men stationed above the protective deck, only 24 are without armor protection, and these have the duties least necessary and are widely scattered; 26 have the partial protection of the armor protecting the 6-inch guns, being distributed in 4 groups at considerable distance from each other; 52 are in the 8-inch turrets, in 4 groups entirely isolated from the rest of the vessel; 28 are in the 13-inch turrets, in two groups entirely isolated, and comparatively speaking, enjoying absolute security.

(3) The casualties will thus not only be moderate and take place among those who least affect the vessel's welfare, but they will have no effect to speak of on the rest of the crew, particularly those associated with the important guns, who will be in entire ignorance of casualties outside of the turrets. A panic can take place only when the hull is injured, affecting the ship as a whole, and then it will be greatest below the protective deck, where there would be the fear of being imprisoned if the vessel went down. The vitals, not the guns, would be neglected before real destruction took place. In regulating the co-ordination of protection, if consideration is given the possibility of a panic, it should cause the addition of protection to the hull, not to the guns as advanced.

(4) The exposure of the personnel on the Indiana is thus as follows: for motive power, no exposure; for the 13-inch guns, 22 men in the magazines, no exposure, 28 men in the turrets, practically no exposure; for the 8-inch guns, 24 men in the magazines, no exposure, 52 men in the turrets, exposure to heavy guns only; for the 6-inch guns, 10 men in the magazines, no exposure, 26 men partially protected; at machine guns, 6 men with slight protection; wholly exposed, as above, 24 men.

Thus a battle-ship may be considered as having her motive power exempt from the effect of casualties, her heavy guns practically exempt, her medium caliber guns partially exempt, and the other personnel exempt in proportion to importance, while danger of panic can arise only from injury to the hull, when the vitals, not the guns, will be most affected.

Thus in sum, the issue where battle-ships are engaged will be but slightly affected by casualties to the personnel.

3. It is injury to the hull that will determine the issue in usual cases. The form the injury will take, whether sustained by floatability, stability, uprightness, vitals, or by combinations of these features, will vary with, and should be studied for, each individual vessel; it will be seriously affected by the condition of the sea and by the manner in which the attack is made. Taking our own battle-ships for examples, and speaking broadly, it will probably be injury to the vitals that will decide their fate. They will probably blow up from a boiler or magazine explosion, or have the engines or steering gear wrecked; the Indiana, Oregon and Massachusetts will probably have their stability overcome and turn turtle, if not first disabled or destroyed by injury to the vitals. In each case, all of the heavy turret guns and a part of the 8-inch guns, the proportion being greater as the sea runs higher, will probably still be in action when the end comes.

A. CRONEAN,* Naval Constructor, French Navy.—The objections raised by Assistant Naval Constructor R. P. Hobson, U. S. N., to the adoption of disappearing guns are of the most serious kind.

I wrote, a few years ago, in my essay on Guns, Torpedoes and Armor:† "The protection to be given to the water-line is proportionate to the protection afforded to guns. . . . If ships are constructed in which the guns have little or no protection, it will be sufficient to give the water-line comparatively small protection. The danger of sinking or turning over must be just a little less than that of having all the guns on board disabled one after the other." As it is easier to protect a gun by thick armor than to protect the hull, the weak point of modern war vessels is consequently (as Mr. Hobson clearly points out) the protection of the vessel itself, either below the water-line or a little above. An increase of protection to guns is then by no means to be wished for, at least in the present state of things, unless it should be obtained without any increase whatever of obstruction or weight.

Now, it is obvious that the introduction of disappearing guns on board ships would necessitate new organs, which would render a modern warship more obstructed than ever. A vessel of war may be compared to a sort of clockwork, the different "movements" of which are not to be multiplied *ad infinitum*.

As far as regards weight, it seems to result from Mr. Hobson's note that, in some cases which it is beyond our purpose to examine, some advantage might be gained by the adoption of the disappearing gun. This, however, in my opinion, would only hold good for coast-defense vessels. Mr. Hobson himself (see page 610) makes a distinction between coast-defense vessels and sea-going battle-ships. With the former, the gun remaining at the same level, we can, if we suppose that it will be raised only for a very short time, reduce the thickness of its armor,

*Instructor at the French National School of Naval Design, author of "Construction Pratique des Navires de Guerre," "Canons, Torpilles et Cuirasse," etc.

†"Canons, Torpilles et Cuirasse."

taking for granted that there is less danger of its being struck. In that case some advantage might be gained. But, if the ship under consideration is a battle-ship, as the fitting of a medium caliber battery will oblige the constructor to place his turrets one deck higher up than in the case of a coast-defense vessel, the aforesaid advantage must needs prove to be a mere loss. Judging from the sketches, the pit is protected by very thick armor, as thick as that of the armored turrets for the heavy guns now in use; and indeed it ought to be so, for a fragment falling into the pit might prevent the turret from rising and revolving, and consequently disable the gun. But that pit is larger than one of our modern turrets, not only in breadth, but also lengthwise, since it must be long enough to house the chases of the guns. In short, the protection to pits has the same height as the armor of one of the Iowa turrets, and a larger horizontal section; it then weighs more, and as the weight of armor of the moving part and the weight of the hydraulic raising gear have still to be added, the increase will indeed be considerable if the use of that system is not strictly limited to coast-defense vessels.

I have but little to say as regards the increase of defensive power. On shore the disappearing gun is rational, because as soon as it has disappeared, the projectile which would have struck it falls further on, with little or no damage. On the contrary, on board ships the gun cannot be considered apart from its floating carriage. It may be hoped that modern turrets, besides shielding the gun from the shots that strike its armor plating, will in some measure protect the decks and hull. But the disappearing turret would by no means afford the same protection, since in most cases the vessel would be reached instead of the turret, and the damage would be still greater.

The most interesting point of Mr. Hobson's paper is that the constructor might seek to obtain through the adoption of the disappearing gun an increase of offensive power by increasing the arc of fire so as to avail himself of the successive disappearance of the guns immediately after firing. Mr. Hobson's remarkable calculations give us a correct idea of the importance belonging to the improvements of the raising gear. In this there may be some theoretical advantage. But, practically speaking, it would certainly be difficult to avail one's self of the advantage thus gained. The period of loading would not be exactly the same for two turrets of equal caliber; the rise and fall would be more rapid with one than with the other, and turret No. 1, when raised, would hide the enemy from gun No. 2. Besides, it will be difficult to avoid delay in the command of the two turrets, especially if the commanding officer bears in mind that one of his guns may fire upon the other in case of slow working of the turrets, or simply if his commands have been misinterpreted. Moreover, circumstances will happen at sea in which all the guns on board cannot fire; in bad weather, for instance, the aft gun alone will be available. In such cases there would be considerable loss of time if the gun had to disappear after each round; or otherwise safety would be diminished if the gun

remained in its firing position, since we take it for granted that the thickness of plating of the moving part would be reduced in disappearing turrets.

Besides, it seems probable that, in an engagement, an officer who has been for some time in command of his vessel will prefer using his turrets in their firing positions, and will altogether renounce the questionable advantage to be gained by the increase of offensive power.

On the other hand, Mr. Hobson clearly states that the increase of offensive power would be of some importance, especially for heavy guns, such as the "Peace-maker," for instance. In this discussion Mr. Hobson compares the quantities of energy developed in a given time by two guns, one of 8-inch, the other of 12-inch, and concludes as follows: "To make the comparison more complete, a factor representing the relative qualities of the two energies should be introduced. This factor would vary in each engagement with the nature of the target, depending upon its relative vulnerability to hostile energy in the form of 12-inch projectiles and 8-inch projectiles in movement. It will be sufficiently accurate for the present purpose to assume that the average target with which the vessel is designed to engage is equally vulnerable to the two kinds of energies, that the quality of unit quantity of energy is the same for both batteries."

In this assumption Mr. Hobson is quite right. Though it would be beyond our purpose to examine whether the target would indeed be equally vulnerable to the 8-inch and 12-inch guns, I think that guns below the 12-inch caliber can be used with advantage to-day. Then, if the 12-inch gun is too heavy, and lighter guns are better suited to the purposes of modern war, there is no reason why we should have recourse to mounts which would only be advantageous in the case of heavy guns firing a comparatively small number of rounds.

In short, the adoption of the disappearing gun on vessels of war, though interesting in the theoretical point of view, seems, practically speaking, to be especially suited to vessels armed with heavy guns and exposing a reduced target to hostile fire—to vessels of the Katahdin type, which, instead of being ram-ships, would be changed into monitors. This, at least, seems to clearly result from Mr. Hobson's interesting paper.

Assistant Naval Constructor HOBSON.—The above interesting and valuable discussion arrived after the reply to the other discussions had been prepared. This reply, however, requires no modification, for the discussion is covered by the remark at the beginning of the reply, that the ideas advanced agree with and emphasize the conclusions arrived at in the paper. There is one exception, however, though it proceeds from the misinterpretation, the one likewise made in the first discussion, that the treatment of the paper in its consideration of the general principles was intended to apply to the pear-shaped barbette shown as inclosing the entire gun. Fig. 13, page 609.

This figure was suggested to accompany the inventor's sketch and

illustrate how it would appear when reduced to the form of a possibility. The protection by heavy armor of the robust chase of the modern gun, with its oblique surface, narrow rectangular target drawn out horizontally, is not desirable, and the increase in weight of armor involved is altogether inadmissible. It is not the disposition shown in this figure, but that of the figures on page 611, which is treated in the paper; in this case the barbette is circular in section and of about the usual diameter, with gateways cut for the chases of the guns in descending. When it is further recalled that the command of the guns there shown remains the same as for the usual turret guns, that they are not supposed to be raised a deck higher in order to be above the medium caliber guns, but that the latter are placed lower, the difficulty of so disposing them being elsewhere treated, it will be seen that the difference, advanced as to the question of weight, disappears altogether. The conclusion on this subject arrived at in the paper is beyond question.

There is no occasion to take issue with the idea advanced that conditions can be imagined such that, as when a portion of the battery is out of action, it might be disadvantageous to have the disappearing privilege, not caring for it at the time while it entailed inferior protection. It need only be remarked that this observation, founded on a conception of the employment of unperfected mechanism, enters the category of the disadvantages pointed out as incurred by such mechanism, annulling quickly all the advantages sought. On the conception of perfected mechanism, where the gun is below when desired only during its inert period, being raised but a fraction of this time, assuming a gun of large caliber, for the purpose of firing, while thus losing little, if anything, in rapidity of fire, enjoying a mean protection equal to or superior to the uniform protection of a heavy turret, it still possesses a possible recourse to greater security. Indeed, admitting perfected mechanism, the more precious the guns become, the more precious become the advantages pointed out. The supposition of perfected mechanism being made, the conclusions of the paper cannot be avoided.

Among the conclusions in the valuable discussion referred to, special note should be taken of the one that confirms the value of the 8-inch guns by the admission of equality with the 12-inch guns in quality of energy generated, an admission that perhaps could not be allowed under all conditions, though easily granted for a general comparison, in view of the great area of most important armor outclassed by the 8-inch guns. It will be seen, referring to page 612, that though in a single round the 12-inch guns of the Iowa generate 104,000 foot tons, and the 8-inch guns but 64,000 foot tons, yet in a given time, sufficiently long, the total energy of the 8-inch guns will exceed that of the 12-inch guns in the ratio of 16 to 13.

Finally, it should be remarked that where special reply has not been made to divergence in any discussion from the conclusions of the paper, it will be found in each case that opposing positions taken in other discussions form ample reply.

Suggestions for Increasing the Efficiency of our New Ships.

(Discussion continued from No. 75.)

Lieutenant Harry P. Huse, U. S. Navy.—Mr. Baxter, in his essay advocating simplicity in the design of men-of-war, has given form to an opinion long held by our sea-going officers. The "box of tricks" has never met with favor among seamen. But the essayist has left one point untouched which opens up almost as wide a field as that covered by his essay, and is closely connected with it. I mean the sacrifice of efficiency for the sake of the beautiful. Throughout the service, the ornamental pilot-houses, chart-houses, skylights, and other structures of the kind are made handsome with panelings and polished woods, but they would furnish great quantities of splinters to be scattered among the neighboring guns' crews. Boiler-iron and cork-paint would be more efficient, but are not used because they would not look as well. The mahogany skylights of the Cincinnati excite the admiration of all visitors, but they add considerably to the weight on the poop and interfere with the efficiency of two of the most important guns of the ship. A handsome booby hatch on the same ship paneled and made of polished mahogany is entirely unnecessary, but is carefully placed between the two after 5-inch R. F. guns so as to interfere with their loading and training.

The desire to make ships resemble yachts has detracted from their efficiency. And what a mistake it is even in striving after the aesthetic! A man-of-war is never so beautiful as when cleared for action, when all unnecessary fittings are removed, and when every effort has been made to make the ship as bare as possible.

Mr. Baxter is right when he says that the comforts of the officers have been increased while those of the men have been lessened. The truth seems to be that when the comfort of the crew conflicts with the efficiency of the ship the crew have suffered; whereas, in the officers' quarters everything has been sacrificed to elegance and to their convenience. A man-of-war is primarily a fighting machine. Consistent with its efficiency in a purely military sense, it should be made as comfortable as possible for those who live on board. Aestheticism should never for one moment be allowed to trench upon either of these attributes.

PROFESSIONAL NOTES.

OFFENSIVE AND DEFENSIVE WEAPONS AT THE BATTLE OF THE YALU.

[DEUTSCHE HEERES ZEITUNG.]

The battle of the Yalu was the most important event in the conflict between China and Japan. It secured to the Japanese Navy the supremacy in the Yellow Sea at the very outset.

This battle is, of course, a very incomplete picture of what would occur in a naval battle in the Mediterranean, for instance, between European fleets. The strength of the Chinese was superior to that of the Japanese; but the condition of the material, absence of rapid-fire guns, and miserable training of the personnel placed the Chinese in an inferior position. Without dealing with questions of naval tactics, we may consider certain phases and results upon which the personnel had but little influence, and arrive at conclusions.

1. THE HULL.—The vital parts suffered comparatively little, but the upper works and military masts were penetrated, and the crews were injured by flying splinters and pieces of the hull as much as by the shell and bullets.

All superstructures increase the number of flying pieces, offer an increased target, and cause the explosion of projectiles which would in their absence have passed over harmlessly. The upper works should, therefore, be reduced to a minimum, consistent with the object of obtaining the necessary accommodation and seaworthiness.

Numerous fires broke out in cabins and in coal-bunkers. Woodwork and upholstery should be avoided. The Japanese officers concluded that all bedding and hammocks should be stowed below. The present means of putting out fires aboard ship are insufficient.

It was further shown that light parts constructed of soft metal suffered least by the passage of projectiles, and admitted of easy subsequent repairs, where the harder metals were shattered or splintered.

2. ARMOR.—Armor played an important rôle; it stopped rapid-fire projectiles. Everything unarmored was penetrated and shattered; but a thin armor along the whole freeboard would certainly have been of greater protection than the armor belt of great thickness. This is more evident even in view of the employment of melinite shell in the future. There were few hits at the water-line. The average hits are very much higher, and the penetration is less in practice than in theory, in consequence of the angle of incidence, which departs considerably from the normal. Armor did not insure success, for the Japanese vessels were much less protected than the Chinese in this regard. It seems evident that the great dead-weight of armor would be more efficient if put into the battery and guns. The hypothesis that a vessel whose dead parts have been destroyed will continue the battle

is illusive. The vessel may float, but may be looked upon as deserted and out of the fight.

The Chinese would have lost fewer ships if a greater number of them had been fitted with transverse bulkheads.

None of the engaging vessels were fitted with nickel steel or Harveyized armor. Coal afforded protection, as on board one of the unarmored Chinese ships a heavy projectile was kept out by the coal.

3. THE RAM. — The ram did not come into play, although several attempts at ramming were made. But the ram is not to be despised on this account, as it may be of the greatest effectiveness against a vessel partly disabled by gun fire or torpedoes; or a vessel, finding its gun fire ineffective, may by a bold attempt at ramming disable or sink a better armed but sluggish opponent.

4. SPEED.—Speed played an important part. Admiral Ito with his fast vessels was enabled to select his fighting distance, and by rapid movements to lessen the chances of being struck by Chinese projectiles. The battle demonstrated that a rapid, well-armed vessel can enter into combat with battle-ships. It has increased the supporters of rapid cruisers carrying heavy batteries.

The Chinese vessels found greater protection in the distance at which Admiral Ito remained than in their armor. But this constant manœuvring at high speed necessitates large coal supply. The necessity of enlarging the radius of action is emphasized.

5. AUXILIARY CRUISERS.—The auxiliary Saikyo was not fitted to take part in battle. She was surrounded and deprived of her rudder, in imminent danger of capture or destruction, so that part of the Japanese fleet had to go to her assistance. Auxiliaries are valuable, but unless they possess high speed and a powerful armament should not be dragged into an action where they are an obstruction rather than of any assistance.

This instance serves as a good example of the degree in which a fleet or squadron may be hampered by a slow vessel.

6. SMALL-ARM FIRE played no part. Gatlings may be useful on certain occasions, but the rifle which requires the detachment of a numerous personnel from other important duties has little effect compared to that of gatlings at all distances.

7. TORPEDOES.—The automobile torpedo played a very insignificant part. Owing to the destructive effect of the artillery fire on the gun-decks, the presence of charged torpedoes in the launching tubes is a constant menace. The Japanese generally left the torpedoes in the torpedo or storerooms. Several Chinese vessels freed themselves by throwing their torpedoes overboard. Under-water tubes do not possess these dangerous features.

The training and elevating gear of the tubes worked badly, which caused some officers to advocate fixed tubes. The Chinese made several attempts to sink Japanese vessels with their torpedoes, but, though launched at distances of only 80 meters, they missed the target. This shows evident ignorance of proper launching, and besides, this distance was too small for torpedoes which are forced to make a large initial dive owing to height of tubes above water. Had the Japanese fleet been aided by its torpedo-boats the disaster to the Chinese fleet would no doubt have been even greater.

8. ARTILLERY.—The battle was decided essentially by the gun. The heaviest guns of the Chinese were 30½-cm. Krupp guns, as opposed

to 32-cm. Canet guns of 40 calibers length of the Japanese. A shell from one of the latter guns struck a Chinese vessel, partly penetrating, tearing away an armored bulkhead and sinking the vessel. The barbette turret of the Matsushima was partly destroyed by the 30½-cm. shell, and the 32-cm. gun could fire only four shots. A 30½-cm. shell exploded on the deck of the Matsushima, causing an explosion of stored shell and killing and wounding about 80 men. These heavy guns proved more effective than those of smaller caliber, especially as the armor in question was only of medium thickness; and it cannot be denied that, leaving out the question of penetration of heavy armor, large shell traveling with high velocities destroy everything in their paths and effect terrible damage. It was demonstrated that one lucky hit with a shell of large caliber will sink a ship.

It was further proved that simplicity in the service of heavy guns is an important factor. The loading is much too slow. The hydraulic apparatus worked well at the beginning, but fragments from exploding shells soon shattered pipes, destroyed the hoisting apparatus or disabled the training gear, necessitating service by hand. This is a new argument in support of the claims of advocates of balanced turrets and mechanical hand gear in place of complicated system of pipes and other contrivances for service of the guns. Electric appliances are just as vulnerable as the hydraulic gear, but much simpler. Furthermore, it was shown in an official report that the hydraulic system suffered in consequence of the low temperature, so that fires had to be kept in the turrets and near the pipes to prevent freezing up. It is believed that electric motors would give less trouble.

The rapid-fire guns decided the battle. They permitted the Japanese to penetrate or destroy the dead works of the Chinese vessels from the very beginning. The Japanese possessed manifest superiority in this regard over the Chinese, who possessed Krupp guns with slow breech mechanism.

The firing was wild, and waste of ammunition considerable. It was noticed that many of the Japanese 12-cm. shell failed to penetrate the Chinese armor. At the fighting range they seemed to possess too little energy. The muzzle velocities were less than 700 meters; had these velocities been greater the results would have been very different.

ARTILLERY IN THE BATTLE OF THE YALU.

[MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.]

The Japanese attribute their victory to their rapid-fire guns. They manœuvred in such a manner as to fight at 2000 meters, forcing an artillery duel in which, with their rapid-fire batteries and better trained crews, they were enabled to frequently set fire to the Chinese vessels. The fires started on board the Japanese ships were soon put out with better facilities and superior organization. In the Chinese vessels the flames were caused by presence of hammocks, sails, wood and other inflammable objects. Fire during action is demoralizing. It would be interesting to know whether the decks were wetted down before the action. The Chinese left their boats in port before the action. This may have been a good plan, for even though boats be not struck by

the enemy's projectiles, they are rendered unserviceable by the concussion of one's own battery.

CONCENTRATED FIRE.—In days of sailing ships it was possible to cut off a part of the enemy's fleet and to concentrate fire upon this part with the object of destruction before aid could come from the remainder of the fleet. With steamships this is impracticable, but why should the fire of all guns of a fleet be not concentrated upon a single vessel of the enemy? A disabled vessel will hamper the enemy's movements, as his manœuvres will have to be altered in giving protection; furthermore, it would seem productive of better results than if each vessel fires without distinction upon the vessel nearest to it at the time.

BROADSIDE VERSUS FORE AND AFT FIRE.

A study of this latest sea fight will naturally lead to a comparison of broadside and fore and aft fire. Is there not a sacrifice of the former in favor of the latter in modern war vessels? A vessel should be able, of course, to sweep the horizon with its guns; yet it is the broadside which will decide the battle, especially in fleet actions. A vessel with its keel-line towards the enemy affords a better target than when its broadside is presented, for the difficulty in hitting lies in the proper elevation, and a projectile which just clears a ship in the latter position might hit if the elongated target of the former position were presented. An ordinary vessel presents in this position a dangerous space of about 300 feet, while the beam of say 36 feet is not a difficult target for a good marksman. In the past everything tended to avoiding this position. Our forefathers had more war experiences than we, and why should we depart from their rules, and by fitting our ships for fore and aft fire expose them to the raking fire which will prove just as disastrous in the modern cruiser as in the old frigate? In the sea fights of the French Revolution the French frequently used with effect the line ahead to receive the attack of an attacking fleet advancing in line abreast. The tactics of Rodney, St. Vincent and Nelson to concentrate their fleets upon a portion of the enemy's fleet counteracted this formation of the French. In our days such concentrated attacks can be met or parried, and the action will soon resolve itself into an exchange of broadside fire, whether in fleet or single action.

The importance of secondary batteries was demonstrated in case of the Matsushima, which was able to continue in the action even after her heavy gun was disabled. Another lesson taught is the necessity of providing for service by hand of heavy guns, in case of the destruction of the hydraulic or mechanical gear.

The importance of subcaliber practice was shown in the superior marksmanship of the Japanese.

The frequency of fires on board the ships testifies to the effectiveness of the modern fuzes. At about the same time an English man-of-war was able to test the fuzes during the bombardment of an African village. They were found, perhaps, too sensitive, as contact of the shell with trees or limbs frequently exploded the Hotchkiss 47-mm. base fuze. Cordite was used on board the Yoshino and gave admirable results, having apparently suffered no deterioration from change of climate.

The Japanese possessed superior arrangements for supply of ammunition. The empty shells were thrown down the open hatches after

fire, and in spite of this rough treatment most of the cases were in a condition to be reloaded after the battle.

The utility of gun shields was rendered doubtful by the battle. Though affording protection at short ranges against small-arm fire, yet at long ranges the thickness is not sufficient to keep out large projectiles, and will invariably explode shell striking them. If not properly secured, the shield when struck and carried away also disables the gun.

H. G. D.

DETERMINATION OF THE FIGHTING VALUE OF A VESSEL.

(Method of Captain Bettolo of the Italian Navy.)

[MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.]

To compare the fighting efficiencies of different vessels, an ideal ship embodying to the highest degree the defensive and offensive strength is taken as a unit or type, and the following formula is used:

$$B = K.f(S)\{f(q)+f(d)+f(v)\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this formula certain relations exist between the functions S of displacement, q of offensive power, d of defensive power, v of speed.

If Δ represents the displacement, Q the offensive power, D the defensive power, and V the speed of the ideal ship used as unit; then

$$f(S)=\frac{S}{\Delta},\ f(q)=\frac{q}{Q},\ f(d)=\frac{d}{D},\ f(v)=\frac{v}{V},$$

and formula (1) becomes $B=K\frac{S}{\Delta}\left\{\frac{q}{Q}+\frac{d}{D}+\frac{v}{V}\right\}$ . . . . . (2)

The coefficient K expresses the degree in which the vessel under question possesses the offensive and defensive qualities referred to those of the most modern types of vessels.

In vessels recently launched K has the value 1, in older vessels K is a fraction. The following values have been assigned to K:

For vessels launched	since	1886,		$K=1.0$
"	"	"	between 1881 and 1885,	$K=.9$
"	"	"	" 1876 and 1880,	$K=.8$
"	"	"	" 1871 and 1875,	$K=.7$
"	"	"	" 1866 and 1870,	$K=.6$
"	"	"	prior to 1865	$K=.5$

In wooden ships K is to be further multiplied by $\frac{2}{3}$.

First a battle-ship, next a cruiser, is brought under consideration.

Displacement.—The greatest displacement being 15,000 tons, $\Delta=15000$ in equation (2).

Offensive powers.—The offensive strength is based upon the total energy developed from the armament, and proportional also to the number of torpedo tubes. If E represent the total energy on the unit ship, e that of the vessel considered, and N the number of launching tubes of the former, n that of the latter, we can substitute $(\frac{e}{E}+\frac{n}{N})$ for $\frac{q}{Q}$ in equation (2). In determining the energy of the guns, regard has been taken of the rapidity of fire, supposing that similar conditions obtain in all nations.

Assume $E = 100000$ meter kilograms (this value is the sum of the energies imparted by five 14".56 Canet guns to their projectiles).

In order to take into account the greater destructive effects of the heavier calibers, the following percentages are assumed, which enter into the above solution:

With guns of	37 cm. (14″.6) to 45 cm. (17″.7)	100%
"	32 cm. (12″.6) and 34 cm. (13″.4)	90%
"	25 cm. (9″.8) and 27 cm. (10″.6)	80%
"	19 cm. (7″.5) and 20 cm. (7″.87)	70%
"	14 cm. (5″.5) to 17 cm. (6″.7)	60%
"	12 cm. (4″.7) and 10 cm. (3″.9)	40%

We assume six torpedo tubes on our ideal ship. If we followed the above rule we should find $\frac{n}{6}$ as a factor to express the power of the ship in question. But as an increase of n would increase the value of $\frac{q}{Q}$ to a greater extent than the addition of a corresponding number of launching tubes would increase the offensive power of a heavily armed battle-ship, the expression $\frac{\sqrt[3]{n}}{\sqrt[3]{6}}$ is supposed to be nearer correct. The cube root is introduced because the total number of torpedoes and their explosive charges is proportional to n, whereas the submarine destruction possible from a ship is proportional to the cube root of the total weight of its explosive charges.

$$\therefore \frac{q}{Q} = \frac{e}{1000} + \frac{\sqrt[3]{n}}{\sqrt[3]{6}}.$$

Defensive power.—In considering this factor, only vertical armor is taken into account, as the other protective means, such as protective deck, water-tight compartments, etc., enter into the coefficient K, which indicates to what extent certain modern protective features obtain on board the vessel under consideration.

The efficiency of vertical armor depends upon two factors: upon its thickness, and upon the ratio of its area to that of the ship's side. Let L = the ratio of length of side armor to length of the ship,

H = height of vertical armor, in meters,

T = thickness of armor in centimeters,

$\therefore d = f(L, H, T)$.

In considering the thickness of armor plates as applied in modern vessels, and their behavior when struck by projectiles, the following principles are taken into account:

1. That plates of 10 to 15 centimeters (3.94 to 5.91 inches) thickness keep out small-calibered projectiles, and weaken the explosive effects of large caliber projectiles by causing their explosion outside the ship before they have penetrated.

2. That although the resistance of heavy plates against penetration depends in the first place upon the thickness, yet it is not directly proportional to this thickness, varying with a quantity intermediate between the square and first power of the thickness, the exponent of which quantity decreases as the thickness increases. From consideration of ballistic tests, these relations may be expressed by considering

thicknesses up to 10 centimeters of a plate as playing a greater part in the resistance than the remaining thickness of metal. This is shown in the expression $10^3 + (T - 10)$. We therefore have

$$f(L, H, T) = L.\ H.\ [10^3 + (T - 10)\ ].$$

Denoting the corresponding elements in the vessel in question by l, h and t, the defensive power may be expressed by

$$\frac{d}{D} = \frac{l.\ h.\ [100 + (t - 10)\ ]}{L.\ H.\ [100 + (T - 10)\ ]}.$$

If in the vessel selected as type or unit of measure $L = 1$, $H = 4$ meters, $T = 55$ centimeters, the above formula becomes

$$\frac{d}{D} = \frac{l.\ h.\ [100 + (t - 10)\ ]}{580}.$$

Speed.—A speed of 20 knots is assumed as a possible maximum in large battle-ships.

Formula (2) now takes the form

$$B = K \frac{S}{15000} \left\{ \frac{e}{1000} + \frac{\sqrt[3]{n}}{\sqrt[3]{6}} + \frac{l.\ h.\ [100 + (t - 10)\ ]}{580} + \frac{V}{20} \right\}.$$

As there are four terms in summation in the parenthesis in the above equation, the value of each of which cannot exceed unity, and as B can have no greater value than 1, we may introduce 4 as a divisor; obtaining finally

$$B = \frac{K}{4} \frac{S}{15000} \left\{ \frac{e}{1000} + \frac{\sqrt[3]{n}}{\sqrt[3]{6}} + \frac{l.\ h.\ [100 + (t - 10)\ ]}{580} + \frac{V}{20} \right\}.$$

This is for battle-ships. For cruisers the formula is slightly changed. It is to be remarked that torpedoes play a more important part in cruisers than in battle-ships, making it necessary to use n instead of $\sqrt[3]{n}$ in the above formula. In an armored cruiser taken as unit of measure for comparisons of other types of this class of vessels, we may assume $\Delta = 8000$ t., $E = 30000$ mkg., $N = 8$, $T = 20$ centimeters, $L = 1$, $H = 4$ meters, $V = 25$ knots. Whence the formula for cruisers is

$$B = \frac{K}{4} \frac{S}{8000} \left\{ \frac{e}{300} + \frac{n}{8} + \frac{l.\ h.\ [100 + (t - 10)\ ]}{440} + \frac{V}{25} \right\}.$$

H. G. D.

AN EXPERIMENTAL TEST OF THE ARMORED SIDE OF U. S. S. IOWA.

[IRON AGE.*]

For the purpose of this test a target was constructed of the length of one armor plate, consisting of all the framing which exists in the actual ship in rear of such plate, to which was attached in the usual manner the actual armor plate selected for the ballistic test of a group of this armor.

The framing extended the height of the armor plate, and in an inboard

*Abstract of a paper read by Albert W. Stahl, Naval Constructor, U. S. N., at the convention of the Society of Naval Architects and Marine Engineers.

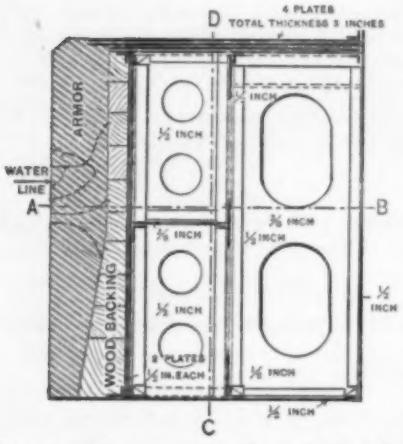


FIG. 1.—*Transverse Section of Target.*

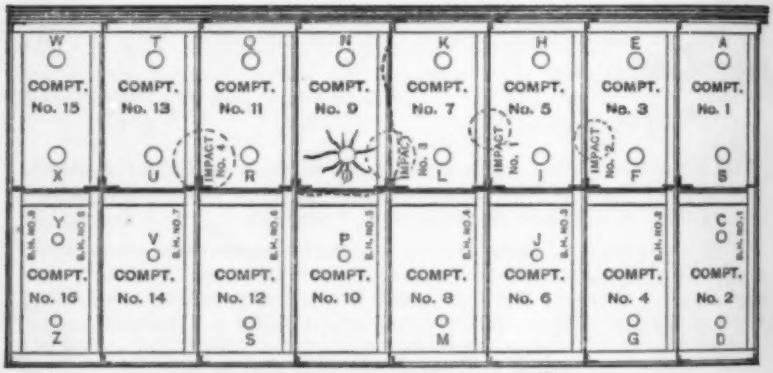


FIG. 2.—*Section on Line C D of Fig.* 1.

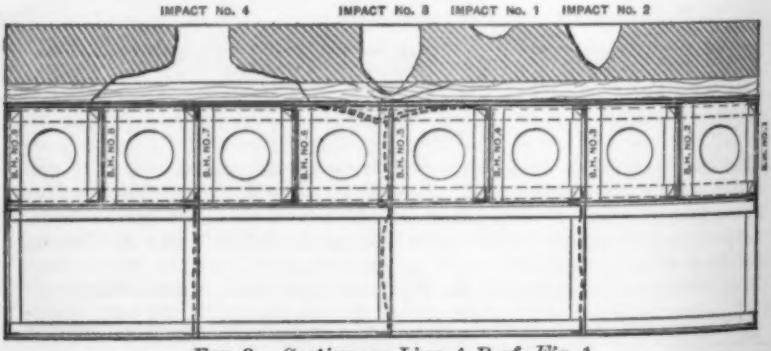


FIG. 3.—*Section on Line A B of Fig.* 1.

direction included the first longitudinal bulkhead within the armor. The total structure was thus 16 feet long over all, 6½ feet wide and 7½ feet high. While such an isolated portion of the ship's side cannot, of course, offer absolutely the same resistance as the corresponding part of the ship itself, thoroughly connected as the latter is with the rest of the hull, yet it was deemed to be a sufficiently fair test to warrant us in accepting the results of the same as representing, with a considerable degree of accuracy, what would happen in the ship under similar circumstances.

Figs. 1, 2 and 3 show the target used in the test. Fig. 1 is a transverse section; to the left is the armor, 14 inches thick in its parallel upper portion, and tapering down to 7 inches at the bottom. Between the armor and the framing proper is the wood backing, 5 inches thick in its upper portion, and tapering to suit the shape of the armor in the lower portion.

Immediately within the wood backing are two steel backing plates, each ½ inch thick; these plates in the Iowa are really ⅝ inch thick, but the lesser thickness was used in the target both as a matter of convenience and to bring it into accord with the ⅛ inch thickness adopted in the design of the two recently authorized battle-ships, Nos. 5 and 6. The rest of the framing consisted of transverse vertical bulkheads ½ inch thick and 2 feet apart, the alternate ones being extended to the rear with a thickness of ⅜ inch and connected to a main longitudinal bulkhead of the ship, while the others were simply stiffened at the rear with a flange consisting of two angle irons riveted back to back. The longitudinal members of this cellular framing consisted of the armored deck above, an ordinary deck below, and a horizontal plate at about mid-height, together with 3 vertical stiffening plates at top, at bottom, and at mid-height respectively. The various portions were thoroughly united by angles and butt straps. Fig. 2 shows also the number and location of armor bolts, of which the upper ones were 2.8 inches diameter, while the lower ones were 2.4 inches in diameter.

This target was secured to a heavy supporting structure so arranged as to support the target at top and bottom only, representing the support due to the decks of the vessel. It consisted of 8 vertical timbers of oak, butting at the bottom against horizontal timbers, and near the top against inclined braces, all these timbers being about 15 inches square. The incline braces were secured to the verticals by heavy angle irons, and by bolts to the horizontals below them. Behind the junction of the horizontal and inclined timbers were placed a set of nearly horizontal timbers 10x9 inches, which in turn rested against piles 20 inches square driven 5 feet into the ground. Running to the front from the feet of the verticals were other horizontal timbers, 15 inches square, the front ends of which were bolted down to doubled cross timbers, 12 inches square, imbedded in the ground. This extremely strong structure was then filled in with sand, so as to render it as rigid and unyielding as possible; and finally the target was secured in the front angle of the same by about 100 1½-inch bolts, being separated from the main structure by cross timbers at top and bottom, the object of the latter being to confine the resistance to the two deck levels, as above explained.

Four shots were fired at this target—two 10-inch, one 12-inch, and one 13-inch—the first two forming the regular acceptance test of the

armor plate, and the last two being specially designed to test the strength of the framing. The angle of impact was practically normal in all cases.

The first shot was fired from a 10-inch breech-loading rifle. The projectile was a Carpenter shell (weight about 500 pounds), hardened to 2.5 inches below bourrelet, with a charge of 140 pounds of powder. The distance from the gun to the armor was 388 feet; the striking velocity of the projectile was 1432 feet per second. This gave a total striking energy of 7622 foot tons, or 286 foot tons per ton of armor, being 1.29 times the energy required to just penetrate a wrought iron plate of same thickness. The shell struck the plate 71 inches from left edge, 27 inches from top bevel, immediately in front of bulkhead No. 4, between armor bolts K, H, L and I, and 8 inches above the center line of second row of armor bolts. The projectile broke up, the head to 6 inches from point remaining welded in the armor, and the balance of the projectile being broken into many small pieces, which were scattered to great distances.

The armor was penetrated 3.75 inches, as shown in Fig. 3, the diameter of shell metal in impact being 10 inches. The diameter of splash was 14.5 inches. There was no front bulge or fringe; back bulge not visible, but probably very slight. No cracks whatever were developed in the armor, and the wood backing seemed uninjured.

The framing suffered practically no damage, only one rivet in the angle in compartment No. 11 being sheared. All the 1.25-inch tap bolts binding the armor deck to top of armor were sheared, due to the fact that in the target structure there was an imperfect fit between the armor and the plating representing the armor deck, thus permitting the former to move slightly relatively to the latter. This has been obviated entirely in the actual structure of the ship.

The second shot was fired from the same gun, being a similar shell, but with a charge of 217.2 lbs., giving a striking velocity of 1856 feet per second. The corresponding total striking energy was 11,954 foot tons, or 448.6 foot tons per ton of armor, being 2.3 times the energy just necessary to penetrate a wrought iron plate of same thickness. The shell struck the armor 45 inches from left edge, 29.5 inches from top bevel, and 25 inches from impact No. 1, in front of lower part of compartment No. 3, just to the left of bulkhead No. 3, and 6.5 inches above center line of second row of armor bolts, near bolt F.

The projectile broke up at the bourrelet, the head remaining in the armor, and pieces of the body and base being scattered around in front of the target. The armor was penetrated 11 inches, the diameter of shot hole being 13 inches. The armor splashed and flaked 17 inches by 18 inches. There was a front bulge ½ inch high and 17 inches diameter. The fringe was very slight, with fine cracks in it. The back bulge was not at this time determined, but the plate in rear of armor and backing was found to have bulged slightly, though it was not cracked. The backing was in good condition, except slight splits at edges of one of the timbers. Armor bolt F was driven to the rear, the end which was screwed into the armor having the threads stripped on side nearest projectile. No damage whatever was inflicted on the framing; though, owing to a slight deformation of the armor, some of the armor bolt fittings became somewhat slack.

The third shot was fired from a 12-inch breech-loading rifle, the pro-

jectile being a Wheeler-Sterling armor-piercing shell (weight about 850 pounds), hardened to 2 inches below bourrelet, with a powder charge of 400.6 pounds. The striking velocity was 1800 feet per second, giving a striking energy of 19,114 foot tons, or 717.23 foot tons per ton of armor plate, being 2.69 times the energy just necessary to penetrate a wrought-iron plate of same thickness.

The projectile struck the armor 95 inches from right edge, 27.5 inches from impact No. 1, and 33 inches from the top bevel, directly in front of bulkhead No. 5, the point penetrating 3.75 inches through the plate. The shell broke up below bourrelet, at about 15 to 18 inches from base, set up and cracked longitudinally from base to bourrelet, the two portions of body and base falling in front of target. The head of shell remained in the shot hole, the point and 3 inches of ogive being detached and carrying the back bulge into backing in rear of armor.

The diameter of the shot hole was 13.75 inches, and the diameter of splash in flaking was 20 inches. There was a front bulge ½ inch high and 2 feet in diameter; fringe slight and cracked around shot hole. A portion of the armor on left side of shot hole was nearly detached. The plate was through cracked from top to bottom, through the impact, and was also partially cracked from this impact to impact No. 1 and to the left of same impact to impact No. 2. The ends of the armor plate moved 1.25 inches to the front and away from the framing. There was no movement in the framing itself. In Figs. 2 and 3 is shown the damage inflicted on the framing by this shot.

The framing of bulkhead No. 5 between compartments Nos. 7 and 9 was buckled 3 inches to the right at the top, and a similar amount to the left at the bottom. The connecting angle iron in lower right-hand corner of compartment No. 7 was bent to an angle of 90 degrees at a point 2 inches from the plating behind armor, but none of the rivets in the angle iron were sheared. The plating behind armor and backing in compartment No. 7 and in the vicinity of impact No. 3 was driven to the rear 2 inches; while in the rear of the impact it was locally bulged 5 inches, carrying with it armor bolt O, which was sheared off by the blow. The fractured armor bolt having been knocked out with a sledge hammer, showed the wood backing compressed to 1 inch on the right side of this bolt hole, while it was of normal thickness on the left. The rear portion of bulkhead No. 5 buckled 2.5 inches at the middle and somewhat less at top and bottom. The rear portion of bulkhead No. 7 buckled ¾ inch and the rear portion of bulkhead No. 3 buckled 1 inch near bottom. The middle horizontal plate between bulkheads Nos. 5 and 6 was buckled ½ inch. Four flush rivets in the ½-inch backing plates, together with the heads of three rivets in one of the angle irons, were sheared off. No other rivets were broken.

Although this projectile actually penetrated the armor, the damage to the framing, as above specified in detail, was trivial; and, so far as the framing was concerned, no repairs whatever would have been needed to enable it just as efficiently to withstand a second blow of this energy had the armor plate not been cracked through. The framing thus fulfilled, and even exceeded, the first condition laid down—that it must suffer no material damage from any shot not fully penetrating the armor.

The fourth shot was fired from a 13-inch breech-loading rifle at a distance of 378 feet, the projectile being a Wheeler-Sterling shell (weight

about 1100 lbs.), hardened to a rear part of bourrelet, with a powder charge of 484.2 pounds. The striking velocity was 1800 feet per second, giving a striking energy of 24,763 foot tons, or 1903 foot tons per ton of armor (considering, in this case, only the detached portion of armor plate struck by this shot), being 3.46 times the energy just necessary to penetrate a wrought-iron plate of the same thickness. The projectile struck the armor plate 39 inches from extreme top of plate, 8.5 inches above bevel line, and 45 inches to right of impact No. 3 and 48 inches from right edge.

The projectile penetrated armor and framing completely, being found 12 feet in the sand butt in rear of target. The shell was found to have been set up 3 inches in length and increased in diameter 0.55 inch at bourrelet. The diameter of shot hole in armor was 14 inches; interior smooth. There was no splash; the mean diameter of flaking was 27 inches. The front bulge was mostly flaked away, that remaining on the armor being ½ inch high and 27 inches diameter. There was a back bulge, 4 inches high and about 45 inches diameter, broken out all around, two pieces of from 500 to 600 pounds each being carried to the rear and lodging in the framing, while other smaller pieces were carried right through with the shell. The armor plate was cracked through from this impact in an almost horizontal line to impact No. 3, also through cracked from top of impact diagonally to top of plate, and through cracked from left-hand side of impact vertically down to bottom of plate.

The experiment concluding with this shot, both armor and wood backing were removed from the framing, for the purpose of further examination. The backing was badly splintered and carried away in rear of this impact. The wood backing was next removed from the armor. None of the armor bolts, except those in the line of impact, were injured.

A detailed examination of the framing after the armor and backing had been removed showed the following effect of all four shots:

Measured at the center line, the face of the structure as a whole was bulged inward away from the straight line connecting the two ends about 2 inches. There was no damage to the plating caused by the two 10-inch shots except a bulge 12 inches diameter and 2 inches high in rear of impact No. 2. Opposite impact No. 3, the two ½-inch plates behind the wood backing were indented 5 inches by the back bulge of the armor, this indentation extending over an area about 3 feet in diameter. Of these two plates, the one next to the backing contained a continuous crack in the indented surface extending from the bolt hole L to bolt hole O, thence upward and to the left 18 inches, almost following a line where the back bulge was broken out. In rear of impact No. 4 these two plates were broken out, making a hole 44.5 inches by 51.5 inches, the ragged points of the metal being folded inward at a sharp angle on the left side, the plating being cracked at the angle. This plating, the vertical bulkhead No. 7, and the rear bulkhead of target structure in rear of this impact were turned, twisted, bent and fluted, the plates being twisted into all sorts of shapes, exhibiting the fine quality of the metal. The holes in the bulkheads were very much larger than the diameter of the shell. Bulkhead No. 7 was cut off 36 inches from bottom and about 12 inches from top. The plates forming the rear part of framing bulged out 19

inches to the rear and were cracked through, the plate being split and bulged over an area of 42 inches wide by 105 inches long, the rivets binding these plates together being sheared over a length of 106 inches.

The upper portion of bulkhead No. 8 was bent to the right 3 inches, and slightly warped; the upper portion of bulkhead No. 6 was twisted to the left about 5 inches, and badly buckled. The intermediate vertical stiffening plate, ½ inch thick and 12 inches wide, was broken through in rear of impact, and carried away between bulkheads Nos. 5 and 8. The similar upper stiffening plate was bent to the rear about 7 inches between bulkheads Nos. 6 and 8. The deck beam at bulkhead No. 7 was uninjured. Bulkhead No. 5 was slightly buckled, the injury to this bulkhead by impact No. 3 having been slightly increased by this impact. Armor bolt U in rear of impact No. 4 fell out from back bulge, broke through and dropped to the bottom of compartment No. 14, the bolt being uninjured except that the portion which screwed into the armor was slightly bent.

Armor bolts V, S, Q and T were in place and practically uninjured. Armor bolt R was sheared at rear surface of plate and thrown to the rear into compartment No. 12. All the timbers of the backing were loosened up and moved away from the plate, the calking being loosened around the armor bolts. Eight of the backing timbers were crushed and broken in two in rear of back bulge of impact No. 4 and six of them in rear of back bulge of impact No. 3. The plate and target structure moved to rear 2 inches. None of the fastenings securing the plate and structure to the wooden target structure were injured. One of the vertical timbers in rear of target was cut in two by the projectile, but remained in place, its inclined brace directly in rear being carried away for a length of 48 inches, the lower part of it remaining in place.

This detailed statement of the injuries inflicted, together with the engravings, shows clearly the extent of the damage. While the injury was very serious behind impact No. 4, where the shell penetrated completely, the important point to note is that it was entirely local, plates and angles a short distance on either side of this impact being practically uninjured; thus satisfying the second condition above stated as requisite. The framing thus, on the whole, showed the effectiveness of its design and clearly demonstrated its complete efficiency for its intended purpose. This test is the most important one that has ever been made, at least in our service, to settle the much discussed question of strength of framing; and it is naturally a great source of satisfaction to all interested in naval affairs to feel that what has been done in the design and construction of such framing in our various ships has been well done, and that no apprehension need be felt on that score.

A POLARIZING PHOTO-CHRONOGRAPH.

In the July number of the Journal of the United States Artillery appears a very interesting and instructive article entitled "Experiments with a New Polarizing Photo-Chronograph, Applied to the Measurement of the Velocity of Projectiles," by Dr. Albert Cushing

Crehore, Assistant Professor of Physics, Dartmouth College, and Dr. George Owen Squier, First Lieutenant, Third Artillery, U. S. A. We had intended publishing this article in full, but find our space so limited that we have been compelled to cut out some of the details, and accordingly we publish the following (mostly an extract), which is all that is necessary to a general understanding of the subject.

The nature of this instrument is such that it is admirably adapted for recording the passage of the projectile at a number of points of its trajectory, which points of observation may be as near together as is desirable. For this reason it was made an object to study the law of variation of the velocity of the projectile near the muzzle of the gun. Its superiority over other known methods of measuring velocities is due to the fact that in recording, no ponderable matter is required to be moved, as is the case with all other instruments for this purpose.

The desirable and possibly essential features of a good chronograph may be classed as follows: There must be some agent in the first place which can transmit, from the phenomenon to be recorded wherever it may be located, the occurrence of the event to a place where it can be permanently made a matter of record. In the second place the agent which is to receive the record must include with it some accurate means of measuring time. For brevity let us designate these two parts of any chronograph by the terms "transmitter" and "receiver." The transmitter will then include all those parts of any chronograph which are instrumental in conveying the occurrence of the event from the place where it happens to the agent which finally receives the record. The receiver includes all those parts that are essential in receiving the record, together with an accurate means of measuring time.

The Transmitter.

In the path of the beam of white light admitted through an aperture is placed a Nicol prism (any other means of obtaining polarized light may be employed) in order to obtain a beam of plane polarized light. This prism is made of two crystals of Iceland spar, which are cemented together by Canada balsam in such a way as to obtain only a single beam of polarized light. The crystal is a doubly refracting medium, that is, a light beam entering it is in general divided into two separate beams which are polarized and have different directions. One of these beams in the Nicol prism is disposed of by total reflection from the surface of separation where the Canada balsam is located, and the other emerges a completely polarized beam ready for use. Each beam has only one component of the vibration of the original light. One beam has all the up and down components, while the other has all the right and left components. As the wave advances, all the motion will thus be confined to a single plane containing the ray. This is the plane of polarization.

Suppose that a second Nicol prism exactly like the first is now placed in the path of the polarized beam. If then the second prism called the "analyzer" is set so that its plane is just perpendicular to that of the first prism called the "polarizer," all the vibrations not sorted out by the polarizer will be by the analyzer. In this position, the planes being just perpendicular to each other, the prisms are said to be "crossed," and an observer looking through the analyzer finds the light

totally extinguished as though a shutter interrupted the beam. By turning the analyzer ever so little from the crossed position, light passes through it, and its intensity increases until the planes of the prisms are parallel when it again diminishes; and if one of the prisms is rotated, there will be darkness twice every revolution.

In order to accomplish the same end that is obtained by rotating the analyzer without actually doing so, the following means is adopted: Between the polarizer and analyzer is placed a transparent medium which can rotate or turn the plane of polarization of the light to another place subject to the control of an electric current without moving any *material thing*. The medium used in these experiments was liquid carbon bisulphide contained in a glass tube with plane glass ends. There are many other substances which will answer the purpose, some better than others. This was selected because it is very clear and colorless, and possesses the necessary rotatory property to a considerable extent. It only possesses this property, however, when situated in a magnetic field of force. The rotatory power, that is, the angle of change of the plane of polarization, is proportional to the intensity of this magnetic field.

To produce a magnetic field in the carbon bisulphide, a coil of wire is wound around the glass tube and an electric current passed through the coil. When the current ceases the carbon bisulphide instantly loses its rotatory power. The operation is as follows: First the polarizer and analyzer are permanently set in the crossed position, so that no light emerges from the analyzer. A current is now sent through the coil on the tube. The plane of polarization is immediately rotated. This is equivalent to rotating the polarizer through a certain angle, and hence light now emerges from the analyzer. Break the current, the medium loses its rotatory power and there is again complete darkness. This arrangement makes an effectual shutter for the beam without moving any mass of matter.

The tube was originally an ordinary chemical laboratory glass condenser tube of 3 cm. internal diameter and 45 cm. long, provided with ground ends upon which plane glass was fitted. Two smaller tubes, projecting from the side of the larger tube near either end, were placed in an upright position so that, when the tube was filled with liquid carbon bisulphide, any bubbles of air which might exist in the liquid would collect in the smaller tubes.

It was found, after trials with a number of substances, that ordinary cane sugar, when melted to a candied condition, would make an impervious cement. The tube was wound with a No. 18 single covered magnet-wire in four equal separate sections along its length.

Resistance of 4 coils in series.....	13.76 ohms.
Resistance of each coil	3.44 ohms.
Resistance of 4 coils in parallel	0.86 ohm.
Total number of turns on tube	2900 about.
Number of turns on each section	725.

The four coils were usually connected in parallel in these experiments, with the object of reducing the inductance of the line, the inductance of the tube itself being reduced sixteen-fold by this arrangement. Since a given strength of magnetic field had to be attained, the line current was therefore larger than it would have been with the coils in series. The current which was ordinarily used was about 17 amperes.

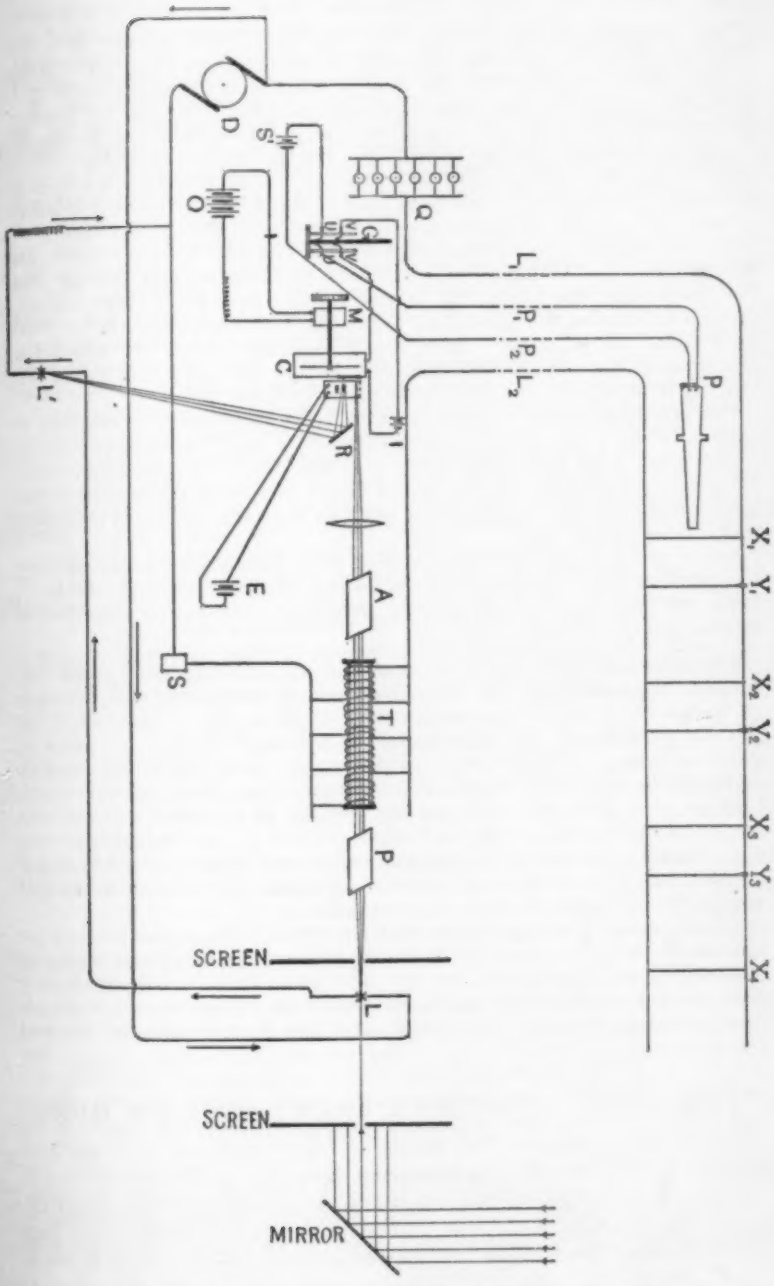
The operation of the transmitter is as follows: When no current is flowing in the circuit, the polarizer and analyzer are permanently set in the "crossed" position for darkness, and then just before firing, the switch S is closed and the current flows through the circuit. This permits light to pass through the analyzer as long as the current is maintained. When the projectile arrives at the muzzle of the gun, the wires of the screen X_1 are broken and the current is completely interrupted. The disappearance of the light through the analyzer is simultaneous with the interruption of the current. When the projectile arrives at the device Y_1 it pulls out an insulating plug and re-establishes the current through X_2. Simultaneously with this, light is admitted through the analyzer, again to be interrupted when the projectile reaches the second screen X_2, and so on. The light through the analyzer is thus intermittent, the transition from light to darkness being so instantaneous as to produce a sharp, well-defined record on the photographic plate of the receiver.

The Receiver.

The receiver is that part of the chronograph which is susceptible of receiving the continuous record from the transmitter, and it also includes that part of the instrument which measures time. It consisted of a circular photographic plate upon a horizontal shaft in a dark box. An approximately uniform rotation was given to it by means of an electric motor, whose armature was coupled directly to the shaft. In order to accurately determine the angular velocity of the plate, whenever it is exposed, a tuning fork is placed so that the shadow of one prong is projected sharply upon it by means of a parallel beam of light from an intense source. The light from the transmitter, as well as the light from the tuning fork, is admitted to the plate through a narrow horizontal slit. When the plate is in rotation, and the tuning fork is vibrating, the shadow of the edge of the fork describes a sinusoidal line around the plate. From a knowledge of the angle on the plate which a certain number of these waves subtend, and the time of vibration of the fork, the angular velocity of the plate at once becomes known.

The Gravity Switch.

It was found necessary in the course of experiment to have an accurate means of exposing the camera at just the proper time in relation to the firing of the gun. A gravity form of switch was constructed with this object in view. It consisted of a wooden base with an upright brass rod in its center. On either side of this rod were two wooden uprights carrying the connectors *VV* and *UU*. To these connectors were attached wire springs bent inward toward the brass rod. The weight was a cylindrical piece of brass four inches long, with a hole drilled through it lengthwise so as to permit it to slide freely upon the brass rod. The gun was fired by dropping this weight down the rod. When the weight arrived at the springs connected with *VV*, the electrical circuit was completed through *VV*, which operated the camera-slide, and upon arriving at the springs connected with *UU* the primer circuit was completed and the gun was fired. The interval of time between making the camera circuit and making the primer circuit can thus be varied within certain limits, by dropping the weight from different heights. The curve of calibration of this switch was constructed, which gives this interval of time for any height from which the weight was dropped.



COMPLETE ARRANGEMENT OF ELECTRICAL CIRCUITS.

CIRCUITS.

The complete arrangement of the electrical circuits used with the different pieces of apparatus is shown in the diagram, in which D is the dynamo, T the transmitter tube, S a switch which completed the circuit of the transmitter just a moment before firing the gun to prevent heating the coils, L_1 L_2 the line wires leading to the proving ground; Q a bank of resistance lamps; $X_1X_2X_3$ etc., the screen wires shunted across between the line wires; $Y_1Y_2Y_3$ etc., the devices for restoring the current successively between the screens; and L and L' two 50-volt arc lamps in series which for convenience were lighted by the same dynamo. The electrical tuning fork is controlled by the cells E; M is the motor for running the camera plate; and at O are represented four storage cells for energizing the same. G is the gravity-switch for exposing the camera and firing the gun, and C the camera whose slide is operated electrically by the cells I from the gravity-switch at VV. The firing circuit contains the electric primer P at the gun, the line wires P_1P_2, the dry cells S', and the gravity-switch terminals UU.

The principal ballistic result obtained from these experiments may be said to be the locating of a maximum point in the velocity curve outside of the gun. This maximum point is, in the case of the gun and conditions of loading described, at six or seven feet from the muzzle of the gun—certainly more than five feet and less than ten—or about 25 calibers in front of the muzzle.

A few preliminary experiments were tried with a view of determining the value of this instrument for the measurement of velocities inside the bore, but any mention of them is withheld until further experiments can be made.

The preceding is in nearly the words of the authors, but is much condensed. In connection with this instrument we would say that extension of its use into ordinary practice seems to lie in the elimination of the gravity switch and the substitution of a sensitized sheet of paper or gelatine film for the circular photographic plate used. We suggest winding the sensitized sheet on the cylinder of a Schultz chronoscope, and see no reason why it should not then be as susceptible to practical use as is the Schultz. The traversing gear of the latter would obviate the present necessity of the gravity switch and allow of the use of this chronoscope as a megagraph without affecting its value in its present distinctive field, that is, as a micrograph.

The instrument is so accurate that the cutting of a screen wire by the side in place of the point of the ogival head of the projectile causes an irregularity in the record. So we may fully expect with its further development to see rewritten the literature on the resistance of the air to projectiles, as well as possibly the thermo-dynamics of the gun itself.

THE LIMIT OF HUMAN ENDURANCE OF HIGH AIR PRESSURES.

[ENGINEERING NEWS.]

The dangers to men working under high pressures of compressed air, due to the pressure itself, and especially to the change from the high to the normal pressure on leaving the air-lock, have long been recog-

nized and studied by engineers and physicians, and it is now well understood that only comparatively young men, of sound constitution, should be employed, that the hours of labor under pressure should be short, that the pressure should be reduced very gradually in the air-lock, that the men should rest after coming out, and that a hospital air-lock should be provided, in which men may be placed and treated with heated compressed air if chilled, afflicted by the "bends" or "caisson disease," or otherwise injured by a too sudden reduction of pressure. A hospital of this kind, as used at the Hudson River tunnel works, was illustrated in our issue of June 14, 1890.

A series of interesting experiments as to human endurance of higher pressures than are usually employed in compressed air work has recently been made by Mr. Hersent, the engineer in charge of the new harbor works at Bordeaux, France, where the quay foundations are being constructed by the compressed air system, and we take the following particulars of these tests from *Engineering*, of London. As the sponge divers descend from 160 to 200 ft. without injury, it was considered that workmen should be able to endure corresponding pressures under the better conditions of an air chamber, and Mr. Hersent therefore formed a commission of doctors to work with him in ascertaining if men could safely sustain a pressure of 70 lbs. per sq. in. The test chamber was fitted with windows, a telephone, electric light and a steam coil, by which any desired temperature could be maintained.

Three men volunteered for the tests; one being a regular compressed-air workman, the second an occasional workman, and the third a man who had only entered the working chamber on a few occasions. These men were subjected to pressures for a length of time, usually about one hour. The tests were commenced with a pressure of about 28.4 lbs. per sq. in., and the pressure increased very gradually, by about 4.27 lbs. per day, to 76.8 lbs. per sq. in., while the time for the pressure reduction was increased about 10 minutes for each 1.42 lbs. increase in pressure. The period of compression was also increased, but to a smaller degree, this being of less importance. All three men sustained without difficulty a pressure of 46.9 lbs., with a reduction period of 56 minutes. One of the men, being indisposed from an independent cause, was then withdrawn. At 58.3 lbs. pressure the man who was used to working in the chamber felt some temporary inconvenience, and at 65.4 lbs. his companion, who was not accustomed to compressed-air work, had to be withdrawn, as he suffered from pains in the side. There was no trace of paralysis, but it was not considered safe for him to continue the test, which was finished by the first man alone, who sustained a pressure of 71.1 lbs. for one hour, the pressure being then reduced in 2 h. 25 mins. When released from the chamber this man took some sulphurous baths, which had cured the pains of his companion, and then underwent the final test, in which the pressure was raised to 76.8 lbs. in 45 minutes, continued for an hour, and then reduced to normal pressure in 3 h. 3 mins. The temperature was increased from 56° F. to 68° F. during the compression, maintained at 68° during the test, and then gradually increased to 86° F. during the reduction of the pressure. The man suffered no inconvenience, with the exception of a tingling sensation, which passed away after a short time. It is considered that, if certain precautions are taken, men in good health can sustain a pressure of 76.8 lbs. per sq. in., that means should be provided for heat-

ing the chamber at will, and that good ventilation should be maintained during the reduction of the pressure. As it has been proved that the workmen should rest after leaving the air-lock, especially after working under high pressures, elevators should be provided to bring the men to the surface. These experiments go to show the practicability of men working under compressed air at greater depths than have yet been attempted.

The greatest pressure thus far used in compressed-air work was 52 lbs., corresponding tc a head of 120 ft., in the East River Gas Co.'s tunnel, described in our issue of July 11. This was the extreme reached on this work. The ordinary pressure was about 45 lbs., corresponding to a head of 104 ft. At the Limfjord Bridge, in Denmark, men worked for some time at a depth of 113 ft.

THE IMPROVED GATLING GUN.

[IRON AGE.]

The Naval Rapid Fire Gun Board have submitted to Captain Sampson, chief of the Naval Bureau of Ordnance, a report on the trial of the improved gatling gun. In its general features the gun is the same as the 30-caliber gun tested by the board last year. It differs in important details, however. The caliber of the improved invention is .236 and the length of the barrels 26 inches. A change in the firing mechanism has been made, and now the operating is done from the right-hand barrel instead of the lower one. The change allows more time for the operation of the extractor, and reduces the danger of disabling the gun by hang fires. A novel electrical attachment is used with the gun, which permits of about 1800 shots a minute being fired, a remarkable showing.

The improved gatling underwent tests in competition with the Browning automatic gun. Later it will have to meet several foreign inventions. The experiments with the gatling gun began with the firing of 100 rounds deliberately. This was followed by the discharging of 100 rounds rapidly. No time was taken for the first test, but in the second the record was 9 seconds. There were no interruptions to the firing. Then 20 rounds were discharged; time 3 seconds. One miss fire occurred. Forty rounds were fired in 5 seconds, 50 rounds in 6 seconds, 100 rounds in 7 seconds, 200 rounds in 13 seconds and 400 rounds in 37 seconds. One man operated the crank, and two men were at the feed. Later 400 rounds were fired in 30 seconds. Without any difficulty 460 shots were fired in one minute.

In the course of the last test one case containing ten cartridges was split laterally. Then followed the firing of 100 rounds deliberately, every fifth cartridge being a dummy. The experiment was satisfactory to the board. Two hundred shots with the extreme elevation and 200 shots with the extreme depression were then discharged, the time for the first being 24 seconds and for the latter 21 seconds. With the barrel moving in train and elevation, 200 rounds were fired in 30 seconds without any interruption. In these experiments two men successfully operated the cranks.

To determine how quickly damaged parts of the mechanism could be replaced, a test ensued of taking out an old and putting in a new lock; the time was 28 seconds. The board fired the gun 20 times with one

lock removed. No interruption occurred, but two unfired cartridges were thrown out. Some ill luck attended the attempt to fire the gun continuously for five minutes. A bullet became jammed in one of the barrels, and in one chamber two cartridge cases were found one against the other, the heads of both having been pulled off. The jams were but temporary. The record of the five minutes' firing was 1980 shots, 40 of which were satisfactory hits. The range was 500 yards. With the range at 1000 yards the number of good hits was ten.

The board then made experiments with the gun having the electric motor fitted on. The motor is attached to the breech of the gun casing by an interrupted screw. The electric current is regulated by a switch, and the connection with the firing mechanism made and broken by a push-button held in the gunner's hand. The weight of the motor and the casing is 106 pounds; their length, 21⅜ inches. The additional length of the gun when the motor is attached is 20 inches. The projection of the central shaft from the breech when the motor is unshipped is $2\frac{7}{16}$ inches. As stated, with the motor in operation, the gun can fire 1800 shots a minute. The board says that several hundred shots were fired, the only interruption being due to the temporary jams in the gun or feed strips, and that the action of the motor was smooth and regular throughout.

PAPER SAILS.

[MARINE RECORD.]

An innovation in yachting circles is now being talked of, nothing less than sails made of compressed paper, the sheets being cemented and riveted together in such a way as to form a smooth and strong seam. It appears that the first process of manufacturing consists in preparing the pulp in the regular way, to a ton of which is added 1 pound of bichromate of potash, 25 pounds of glue, 32 pounds of alum, 1½ pounds of soluble glass, and 40 pounds of prime tallow, these ingredients being thoroughly mixed with the pulp. Next the pulp is made into sheets by regular paper-making machinery, and two sheets are pressed together with a glutinous compound between, so as to retain the pieces firmly, making the whole practically homogeneous.

The next operation is quite important, and requires a specially built machine of great power, which is used in compressing the paper from a thick, sticky sheet to a very thin, tough one. The now solid sheet is run through a bath of sulphuric acid, to which ten per cent. of distilled water has been added, from which it emerges to pass between glass rollers, then through a bath of ammonia, then clear water, and finally through felt rollers, after which it is dried and polished between heated metal cylinders. The paper resulting from this process is in sheets of ordinary width and thickness of cotton duck; it is elastic, air-tight, durable, light, and possessed of other needed qualifications to make it available for light sailmaking.

The mode of putting the sheets together is by having a split on the edges of the sheet, or cloth, so as to admit the edge of the other sheet. When the split is closed, cemented and riveted or sewed, it closes completely and firmly.

THE RAW-HIDE CANNON.

[SCIENTIFIC AMERICAN.]

The cannon held its own against very severe tests. It successfully withstood a pressure of 30,369 pounds to the square inch, but the recoil after this shot broke the trail of the gun carriage, and further tests were impossible, no other carriages being available at the time. The War Department ordered the Ordnance Board to test the cannon carefully. In Syracuse they have been firing the gun privately in an armory for a month past.

The principal claims made for the gun are that it is only about half the weight of an ordinary steel gun, that it is just as durable and much stronger than a steel gun, and that any number of shots can be fired from it in rapid succession without heating it.

The raw-hide gun used July 23 was not a very formidable affair. It was 5 feet 8 inches long and was of 2½ inches caliber. It was mounted on a most elaborate gun carriage, which Mr. Link, the assignee, informed the board was made by the finest wagon-maker in Syracuse. The gun weighs 456 pounds, and, according to the diagram, is made up of layers of steel, raw-hide, and copper wire. The bore is of steel, ¾ of an inch thick at the muzzle and 1½ inches thick at the breech. The raw-hide is 1 inch in thickness at the muzzle and 3 inches in thickness at the breech, and is cut in 4-inch strands. Around the whole is wrapped two layers of heavy copper wire. The gun looked strong enough to stand an ordinary charge, but not an officer present believed that there would be much more than a few bits of the carriage left after the first of the heavy tests had been made.

A PROPELLER LIFE BUOY.

[SCIENTIFIC AMERICAN.]

In an inflatable rubber bag forming at once a seat and a buoy is a metallic bearing sleeve for a shaft on whose outer end is a screw or paddle wheel, waist and shoulder straps preventing the person using the buoy from being washed off. The forward end of the bearing sleeve is forked, the forks being pivoted to an air-tight casing or buoyant chest, against the rear side of which the seat may be folded up. The casing also forms a partial support, and contains the mechanical propelling devices, having at its under side bearings for the horizontal propeller shaft and on its front side bearings for a vertical shaft on whose lower end is a screw whose operation is adapted to uphold the buoy in the water. On the casing is stepped a mast, on which a sail may be set, and a downwardly extending frame supports a pedal shaft, by which may be operated, through a sprocket chain connection, a crank shaft having a bevel gear meshing with a bevel pinion on the vertical shaft, the latter shaft also having a bevel pinion meshing with a bevel gear on the forward end of the horizontal shaft, both shafts and their screws or paddles being thus operated by the pedals and by hand cranks at each side of the casing. There is a rudder on the forward side of the casing, and a compass is mounted just below a lantern supported on a rod in front of the mast. The pedals and crank han-

dles are arranged to be folded, and the blades of the screws fold down upon their shafts, all parts of the device being designed to occupy as small a space as possible when not in use. This device forms the subject of a patent recently issued to M. Francois Barathon, Sr., 21 Boulevard Poissonniere, Paris, France.

SHIPS OF WAR.

[UNITED STATES.]

THE INDIANA.

[AMERICAN ENGINEER AND RAILROAD JOURNAL.]

The Indiana, one of the three coast-line battle-ships authorized by the act of Congress approved June 30, 1890, making an appropriation for the construction of three battle-ships at an individual cost not to exceed $4,000,000, has just been accepted by the Government and placed in commission. The contract for the construction of this vessel was awarded to the William Cramp & Sons Ship and Engine-Building Works, of Philadelphia, Pa. The vessel was launched on February 28, 1893.

The Indiana is built of steel. The hull is protected by belts of heavy armor 7½ ft. wide, 3 ft. of which is above water. This protection runs along both sides of the vessel for a distance of 148 ft. amidships, at the extremities of which the armor turns in toward the center line at an angle of 45° for a longitudinal distance of 24 ft., affording a total broadside protection of 196 ft., and passing around and supporting the armor for the 13-in. gun turrets. On top of this side armor is placed a steel deck 2¾ in. thick, under which are the magazines and machinery. Above this belt of side armor, and extending from redoubt to redoubt, the sides are 5 in. thick with a backing of 10 ft. of coal.

The vessel is cut up forward beneath the water-line, making a powerful ram bow, and doing away with excessive bow waves on account of the easier lines so obtained as well as greatly adding to the manœuvring qualities.

The principal dimensions are: Length on the water-line, 348 ft.; breadth, extreme, 69¼ ft.; draft forward and aft, 24 ft.; displacement, 10,288 tons; sustained sea-speed, 15 knots; normal coal supply, 400 tons.

Between the turrets for the 13-in. guns there is a superstructure in which are placed the 6-in. guns, and above or upon the deck erected thereon are placed the 8-in. guns. A battery of 6-pdrs. is arranged along the top of the hammock berthing and bridge, and 1-pdrs. are placed two forward and two aft, one on either side on the berth-deck. In the tops of the double-topped military mast are placed four Gatling guns, two in each top.

The main battery consists of four 13-in. breech-loading rifles, eight 8-in. breech-loading rifles and four 6-in. breech-loading rifles. In the secondary battery there are twenty 6-pdr. rapid-fire guns, four 1-pdr. rapid-fire guns and four Gatling guns.

In addition to the foregoing offensive phase of the ship, there are six torpedo-tubes, one bow, one stern, and four broadside, two on either side, just abaft and forward of the forward and after barbettes respectively.

The four 13-in. guns are mounted in pairs in two barbette turrets forward and abaft the superstructure on the main deck. The lower part of these turrets, called the barbette, is 17 in. thick, while the turret proper, which rises above this wall of armor, is 15 in. thick.

The 8-in. guns are mounted in pairs in four turrets of similar character, two on either side, on the forward and after extremities of the superstructure deck.

The four 6-in. guns, two on each side, are placed amidships on the main deck. These guns will have local protection in addition to splinter bulkheads, shields and automatic shutters.

The 13-in. guns have an effective arc of fire of 270°. These guns are mounted about 17½ ft. above the water-line. The 8-in. guns are about 25 ft. above the water-line, and are high enough to fire over the 13-in. turrets. These guns have a radius of action of 164°.

The engines are of the twin-screw, vertical, triple-expansion, inverted-cylinder type; diameter of cylinders being as follows: high pressure, 34.5 in.; intermediate pressure, 48 in.; low pressure, 75 in., with a common stroke of 42 in. There are four double-ended boilers, 18 ft. x 15 ft. in diameter, and two single-ended boilers (donkey), 8½ ft. x 10 ft. in diameter. Each boiler and engine is in a separate watertight compartment, in order to localize possible injury.

While the normal coal supply is 400 tons, there is a coal bunker capacity of 1800 tons.

The complement will consist of 475 persons—officers and men. Good quarters and accommodations have been provided, and all the latest sanitary improvements will be installed to insure efficiency and thoroughness in lighting, ventilating, and draining.

While the Indiana was under construction there were innumerable croakers who were ready with all sorts of predictions that the vessel would be so top-heavy that her roll in a seaway would be excessive and dangerous. Great interest was accordingly manifested in her performance on her first trip to sea. On leaving the yard the first run was made to the Delaware Breakwater, where she anchored for the night, to wait for a heavy northeasterly gale to subside. The following morning the vessel put to sea, where, although the gale had abated, there was still a heavy sea running, and all on board were in expectation of being badly pitched and rolled about. Some of the members of the Naval Trial Board got out their instruments for registering the roll of a ship, and were prepared to note the number of degrees. To their surprise the ship rode each wave lightly, and the greatest roll noted and reported was only 1½°.

On October 16 the vessel made a preliminary run over the official course off Cape Ann, Mass., and made an average speed of 15.31 knots over a distance of 62 nautical miles. On this run the absence of the usual vibrations made by the powerful engines of a big ship were particularly noticeable. Another feature was the bow wave cast off by the ship. The torpedo-tube in the bow threw up quite a wave, but the bow of the boat itself cleft cleanly through the water, and the lateral waves, instead of extending many feet on each side of the ship, did not extend much more than 15 ft., and then they converged sharply and clung to the vessel's side, leaving no side wave at all.

The official trial was made on October 18 between Cape Ann and Boone Island. The run to Boone Island was made against the tide in

2 hours, 2 minutes and 7 seconds, with an average speed of 15.24 knots. On the return the passage was made in 1 hour, 55 minutes and 35 seconds, making a total of 3 hours, 58 minutes and 28 seconds for the whole run, or an average speed of 15.61 knots, which was .61 knot above the contract requirements. There was a remarkable burst of speed at the latter end of the run, where a speed of 16.3 knots was attained. At this time 11,800 H. P. were developed. The average H. P. shown during the trial was 9700, which is 700 more than the contract requirements. The maximum revolutions of the screws were 131, and the average revolutions were between 128 and 130. The average steam pressure at the boilers was 165 and at the engines 161. The average water pressure in the fire-rooms was 1 in., and the average temperature was 105°.

After the run was over a helm test was made. The ship was turned in a circle of 400 yds., or 200 less than it took to turn the cruiser New York, and she answered her helm with great promptness.

[ENGLAND.]

THE JUPITER.

[THE ENGINEER.]

The Jupiter is the fifth to be launched of nine similar battle-ships, forming part of what is known as the "Spencer Programme," projected shortly after the Salisbury Ministry made way for that of Mr. Gladstone in 1892. A description of H. M. S. Magnificent and Majestic has already been given. It will be unnecessary, therefore, again to enter into any elaborate description of the class, but a few of the general particulars may be recapitulated. The dimensions are: Length between perpendiculars, 390 ft.; breadth, extreme, 75 ft. 9 in.; depth, moulded from upper deck, 44 ft. 9 in.; mean draught, 27 ft. 6 in.; displacement, 14,900 tons. The protection consists of an armor belt of Harveyed steel, 9 in. in thickness, which extends for 215 ft. At the ends are transverse armor bulkheads, also of Harveyed armor, the lower part being 12 in. thick and the upper 9 in. In addition there is a protective deck of from 3 in. to 4 in. in thickness, extending from end to end of the ship. This deck is arched, and is intended to protect the magazines and machinery from fragments of shells and falling shot. At the bottom the belt, which extends up to the main deck and is about 15 ft. broad, is 5½ ft. below the water-line and before and abaft the belt; the protective deck is at a lower level than amidships, so that the ends of the ship are protected by an under-water steel deck.

As regards armament and its disposition the heavy guns are four in number, of 46 tons weight and 12-in. caliber. They will be mounted in pairs in redoubts of Harveyed armor 14 in. thick above the main deck and 7 in. below, and extending from the protective to a few feet above the upper deck. The freeboard of the vessel is unusually great, the center of the guns being about 27 ft. above the water level. The secondary armament consists of twelve 6-in. quick-firing guns, all mounted in armored protective casemates on the main and upper decks. There are also a number of quick-firing and machine guns variously disposed, and five torpedo tubes, four of which are in compartments below water-level, from which they are discharged, thus obviating the risk of an enemy's fire exploding them prematurely. The spaces below

the protective deck at the ends of the ship are largely occupied with torpedoes and ammunition, and a passage under the protective deck gives access to ammunition tubes of solid armor, leading up to the neighborhood of each of the guns.

The machinery space is divided by means of longitudinal and transverse bulkheads into six water-tight compartments, two of which are devoted to the main engines, and four for the boilers. The engines driving four-bladed twin screws are of the vertical inverted triple-expansion type, of an estimated collective indicated horse-power of 12,000. The speed on trial is to reach about 17½ knots. The boilers, eight in number, are of the ordinary single-ended cylindrical return-tube type. A large coal capacity is provided, there being space for 1800 tons in side bunkers partly above and partly below the protective deck. The steering gear, capstan engine, ventilating and air-compressing engines and the dynamos, all of which are essential to the fighting efficiency of the vessels, are arranged at the ends of the ship below the protective deck. In order to reduce the rolling to a minimum, deep bilge keels are fitted for the greater part of the vessel's length. The hull form, although very fine at each extremity, is tolerably full amidship, the coefficient of fineness below the water-line being .65.

The Venus.

[The Steamship.]

On the 5th September, H. M. S. Venus, second-class protected cruiser for the British Government, was launched from the yard of the Fairfield Shipbuilding and Engineering Company, Limited, Govan. The following is a detailed description of the vessel:

H. M. S. Venus is a second-class protected cruiser, being one of the improved Talbot class of vessels now building in the dockyards. Her dimensions are: Length between perpendiculars, 350 ft.; breadth, extreme, 54 ft.; displacement, 5600 tons. The hull is built of Siemens-Martin steel throughout to Admiralty requirements, on the usual principle adopted in warship construction. She has a cellular bottom extending the full length of the engine and boiler spaces, and before and abaft these the water-tight flats of the magazines, etc., continue the double-bottom right to the stem and stern. Under the protective deck the side compartments for the full length of the boiler space are utilized for stowing coal, and additional cross bunkers are introduced at each end of the boiler rooms, thus giving a complete casement of coal round each set of boilers. The hull is subdivided by longitudinal and transverse bulkheads into numerous water-tight compartments, the number of water-tight doors having been reduced to a minimum, and all being worked from the main deck as well as from below. The stern post, struts, and stem are of phosphor bronze. The vessel has a ram stem, and the structure behind is especially strong and efficiently connected to the general framework of the vessel, with a view to the contingency of ramming. The rudder, also of phosphor bronze, is of the balanced type, and controlled by Harfield's compensating gear below the protective deck. The vessel being intended for foreign service and long cruises at sea, in which the maintenance of a uniform speed becomes essential, she has been completely covered to above the load water-line with teak of a minimum thickness of 3½ in. and coppered.

To secure steadiness of gun platform, so necessary in a vessel intended for war purposes, bilge keels extending for about half the vessel's length

amidships have been fitted. The protection of the vessel consists of a curved deck extending from stem to stern, ranging from 3 in. to 1½ in. in thickness, covering the whole of the propelling and steering machinery, boilers, magazines, etc. In addition, the engines are protected by an armored citadel of Harveyized steel, giving protection from raking fire. The reserve bunkers are on the protective deck over the machinery space, and whilst affording a water-line belt of coal protection they, being subdivided into water-tight compartments, give additional security in the event of damage. An armored conning tower of Harveyized steel is placed forward, fitted up with the usual means of navigating the vessel and directing operations while in action, the whole of the connections for which are protected by a steel tube extending to the protective deck.

An additional director tower is provided at the after end of vessel for operating the torpedoes, and conning bridges are fitted both at the fore and after ends for navigating the vessel under ordinary conditions, with the usual compasses, steering-wheels, etc. Three search-lights are operated from these bridges, and the vessel throughout is fitted with a complete installation of electric light. The coal capacity is normally 550 tons, but provision has been made for carrying a greater quantity if necessary. The magazines and shell-rooms are of ample capacity, and are conveniently situated for working the quick-firing guns, special gear being supplied for manipulating the ammunition. The ventilating and pumping arrangements of the vessel are on the usual elaborate scale observed in ships of this class. The accommodation for the officers and crew is of an ample nature, the latest fittings being provided. The complement of men and officers reaches 450 all told. Her armament consists of five 8-in., six 4.7-in., and eight 12-pounder, all quick-firing guns, and a number of smaller guns. The guns are all protected by extra thick shields. Two submerged torpedo tubes are fitted forward and one discharging above water aft, capable of working the latest pattern torpedoes.

The ship has two masts, fitted with military tops for working machine guns, and rigged with fore and aft steadying sails. A signal yard is fitted on the foremast, as well as the new multiple fire signal lamp at masthead.

The propelling machinery consists of two sets of triple-expansion engines, fitted in two separate engine-rooms, each set having three inverted cylinders and three cranks. The high-pressure cylinders are 38 in. diameter, the intermediate-pressure 49 in. diameter, and the low-pressure 74 in. diameter—all adapted for a stroke of 3 ft. 3 in. The cylinders are separate and independent castings, each fitted with a cast-iron liner, and steam jacketed. Each high-pressure cylinder is fitted with a piston valve, and the intermediate and low pressure are each fitted with double-ported slide valves, all worked by double eccentric and link-motion valve gear. Balance cylinders and compensating rings are fitted to the intermediate and low pressure valves.

The reversing engines are of the all-round type, with worm and wheel gear; and all the reversing levers are fitted with a slot and adjusting screw to allow of the expansion in the cylinders being altered. The back columns are of cast iron, fitted with separate guide faces pinned on, and the front columns are of forged steel, the engines being arranged with the starting platforms amidships. The main condensers are of cast brass, and placed at the wings; the steam is condensed outside the

tubes, the circulating water passing through them. There are two large centrifugal pumps of brass worked by independent engines, one in each engine-room, and arranged with a cross connection so that either or both condensers can be supplied with circulating water from either pump. The feed, bilge, and fire-engines are all independent of and separate from the main engines. They are arranged on the center-line bulkhead, the steam being supplied by a special range of pipes. All the exhaust steam is led into an auxiliary condenser of cast brass, having a small air and circulating pump, one of these condensers being fitted in each engine-room. Everything, it will be seen, is in duplicate about the machinery department. The crank, thrust, and propeller shafting is of forged steel and hollow. The crank pins are fitted with centrifugal lubricating apparatus. The propellers are of gun metal, each propeller having three adjustable blades, and constructed to work forwards. A feed-water filter is fitted between the air pump and feed-water tank to prevent any impurities reaching the boilers. Steam is supplied by eight single-ended boilers, each fitted with three corrugated furnaces, and adapted for a working pressure of 155 lbs. The boilers are arranged in two water-tight compartments, the steam pipes being so arranged that the steam from the boilers in either boiler-room can be used for the engines in either or both engine-rooms. Fans and engines are fitted in the stokeholds, and the arrangement is such that the boilers can either be worked with natural draught with fans not working or with closed stokeholds and forced draught.

It is contemplated that the vessel will attain a speed of 19½ knots under usual conditions at sea with the power provided.

Torpedo-Boat Destroyers with Water-Tube Boilers.

[Engineering.]

Name.	Builders.	Length of Vessel.	Description of Boilers.	Speed on Three Hours' Official Trial.
		ft.		knots.
Boxer	Thornycroft	201.5	Thornycroft	29.17
Surly	J. & G. Thomson	200	Normand	28.05
Ardent	Thornycroft	201.5	Thornycroft	27.97
Bruizer	"	201.5	"	27.97
Starfish	Naval Construction Co.	190	Blechynden	27.97
Janus	Palmers	.....	Du Temple	27.80
Decoy	Thornycroft	185	Thornycroft	27.76
Daring	"	185	"	27.70
Hornet	Yarrow	180	Yarrow	27.63
Salmon	Earle's	200	"	27.60
Shark	J. & G. Thomson	200	Normand	27.59
Banshee	Laird	210	"	27.57
Ferret	"	195	"	27.51
Rocket	J. & G. Thomson	200	"	27.37
Contest	Laird	210	"	27.36
Sturgeon	Naval Construction Co.	190	Blechynden	27.16
Dragon	Laird	210	Normand	27.14
Skate	Naval Construction Co.	190	Blechynden	27.10
Handy	Fairfield	194	Thornycroft	27.04
Lynx	Laird	210	Normand	27.00

The above list gives the trial speeds of all the torpedo-boat destroyers, with water-tube boilers, of which we have records. The speeds given are those obtained on the three hours' official trials, with the contract weight of 30 tons in the shape of coal, spare gear, etc., on board. It is a notable fact that some of these vessels have obtained a better speed on the full three hours than was made during the six runs on the mile. This is to be accounted for by the load becoming lighter owing to the coal being burnt.

Vessels with the locomotive boiler are not included in our table. Such vessels are, it will be remembered, allowed a knot less than those having water-tube boilers, that is to say, the contract three hours' speed is 27 knots for water-tube boilers and 26 knots for craft with locomotive boilers. Under these circumstances it would not be fair to put the latter in a list of order by merit with the other craft.

The Boxer, one of the five boats built by Messrs. Thornycroft & Co., it will be seen, heads the list, standing conspicuously first, with a lead of over a knot, or a total superiority of 3½ nautical miles on the three hours' run. Up to a short time ago she was not only the fastest vessel in the British Navy, but also the fastest in the world. Within the last month, however, her speed has been exceeded by two vessels. The first, the Sokol, although constructed for a foreign power, has been built in England by Messrs. Yarrow & Co. It will be sufficient to say that she made a speed of 29.76 knots on her three hours' trial. Her length is 190 ft., and her width 18 ft. 6 in. The other vessel referred to, the Forban, built by Messrs. Augustin Normand & Co., of Havre, is, we regret to say, British neither in ownership nor construction. The Forban is not a torpedo-boat destroyer, but a large first-class torpedo-boat. Her length is 144 ft. 4 in., maximum breadth on load line 14 ft. 6 in., extreme breadth 15 ft. 2 in., depth 10 ft., displacement on trial about 125 tons, and displacement fully loaded 136 tons. The boilers are of the Normand water-tube type, and the engines triple-expansion. The load of armament, coal, crew, etc., was 16 tons. On an hour's run the mean speed was 31.029 knots. Whether the speed would have been maintained on a three hours' run is a matter upon which we need express no opinion.

There yet remain several of the 42 destroyers to complete their trials—one by Yarrow & Co.; three by J. S. White, of Cowes; two by Palmer's Shipbuilding Company; two by Doxford & Sons, of Sunderland; two by Hanna, Donald and Wilson, of Paisley; one by Earle's Shipbuilding and Engineering Company, of Hull; two by Armstrong, Mitchell & Co.; three by Hawthorn, Leslie & Co.; two by the Fairfield Company; and one by the Thames Iron Works. Some of the above have locomotive boilers. If we add to the above the Dasher, Charger, and Havock, the three boats by Yarrow & Co., with locomotive boilers, which have passed their trials, we have the total number of 42 boats ordered.

The new torpedo-boat destroyers, which are to follow the 42 above dealt with, were originally intended to be 20 in number. Their guaranteed speed is 3 knots faster than that of the first lot, namely, 30 knots. We believe, however, that up to the present only 12 of these vessels have been ordered. They are not all of the same dimensions, but some, at any rate, will not exceed in size the largest of the 42. The extra speed will, therefore, have to be obtained chiefly by an increase in power. The orders for the 12 boats now being constructed have been equally divided between Thornycroft's, Laird's, and Thomson's. All

will have water-tube boilers, the Mersey and Clyde vessels those of the Normand type. The *Western Morning News* states that Messrs. Thornycroft have guaranteed 5400 indicated horse-power for their vessels, Messrs. Laird 6000, and the Clydebank firm 5800 indicated horse-power. What will come out in practice of course remains to be seen. No doubt in the new boats advantage will be taken of recent experience to lighten the scantling of the hulls, but whatever the resources brought to bear, it will be anxious work to get the guaranteed speed. According to the *Western Morning News*, the Thornycroft boats are each to be 272 tons displacement, and the other eight 300 tons apiece. The load, we understand, is to be 30 tons, as with the former craft, so that the larger vessels will have an advantage of a smaller proportionate dead-weight. The new boats are named as follows: Messrs. Thornycroft's vessels, Desperate, Fame, Foam, and Mallard; Messrs. Laird's, Quail, Sparrowhawk, Thrasher, and Virago; Messrs. J. and G. Thomson's, Brazen, Electra, Recruit, and Vulture.

[FRANCE.]

THE BOUVINES.

[THE ENGINEER.]

The small French battle-ship Bouvines, which was launched in 1892, is now completed. She is one of a group of four war vessels originally intended to have been built upon the design of a modified Furieuse, viz., the Jemmapes, Valmy, Bouvines, and Tréhouart. But in consequence of the serious disposition to instability which the Furieuse and Terrible displayed during manœuvres in an ordinary Mediterranean gale, the dimensions of the last two vessels were modified, the beam being increased 12 in. and the freeboard raised about 8 ft. forward, whilst, to compensate partially for the consequent elevation of the forward gun, the caliber of both of them in the main armament was reduced from 34 centimeters (13.4 in.) to 30 centimeters (11.8 in.).

The principal dimensions, etc., of the Bouvines and Tréhouart are as follows, and they differ very slightly from those belonging to the other two vessels, except as regards the particulars aforesaid: Length at the water-line, 284 ft.; beam, 58 ft. 8 in.; draught, 22 ft.; displacement, 6610 tons; indicated horse-power, 8400; speed, 17 knots; coal capacity, 300 tons. An armored belt of steel extends from stem to stern, 17¾ in. in thickness above and 10 in. in thickness below the water-line, this being surmounted by an armored deck of steel 4 in. thick. The turrets for the main armament are oval, and armored with 14½-in. steel plates. They rest upon armored redoubts 12½ in. thick, built upon the armored deck.

The armament consists of two 11.8-in. guns, as before-mentioned, eight 10-centimeter (4 in.) quick-firers, and fourteen smaller quick-firers and machine guns. The main armament is very powerful, the 30-centimeter gun being 45 ft. in length and capable of piercing 35.7 in. of armor. The great length of the weapon is an obvious advantage. It is capable of being fired in a horizontal line, either direct ahead or direct astern, without endangering the integrity of the deck or the structure of the ship; the muzzle projecting so far forward and aft as to clear them from the effect of "blast." Its height above the deck also necessarily

conduces to this end, and gives additional gun command—a very important feature. The position of the eight 4-in. quick-firers is equally good. They are all upon the superstructure, so that when the scuttles are closed the hull of the vessel has no gun-ports to attract observation and fire, whilst each gun is within a stout and capacious steel shield. Many of the smaller quick-firers are equally well placed within the shelter of the fighting tops, of which there are two independently of the conning tower, upon the single fighting mast. Four of the 10-centimeter quick-firers, as well as the guns of the main armament, can be trained axially ahead or astern at the same time. The position of the smaller quick-firers in the fighting tops is one of considerable security, and well thought out by the designers of the vessel, so long as the mast itself remains intact. Here the naval architects of France have adhered to their old policy of providing for "top-fire," which proved so terribly destructive to both officers and upper-deck men at Trafalgar and other actions of that period. We should be sorry to see the decks of our vessels encumbered with the towering monstrosities which rise, like the minarets of a mosque, from the Hoche and Magenta; but, after the experience of the unfortunate crews of the fighting tops in the recent naval actions between China and Japan, we confess that it would be satisfactory to know that some attention was being paid to the safety of the men who would have to occupy this position in the event of the action with our own vessels. The shallow thinly plated cheese-boxes, which contain, upon the Majestic class, no less than four 3-pounder Hotchkiss guns, would be cleared of their occupants in a few moments by the machine-guns of the crews occupying the upper top of the Bouvines, whilst these last would be in comparative security, as they could not be seen.

On the whole we consider that two, at least, of the four new French coast-defense battle-ships are very excellent and serviceable little vessels, and as their cost is less than half that of an ordinary sea-going unit of this class, it is almost a question whether Lord Brassey is not right in his pleading for more armored vessels of a medium size. It must be remembered that the Bouvines, drawing only 22 ft. of water, could go in and out of estuaries which would be denied to the Royal Sovereign and Magnificent, and the fault of small coal capacity could be easily remedied. The quantity of eggs which we are now placing in our 15,000-ton baskets is terrible to contemplate.

The New 23-Knot Cruisers.

[Le Yacht.]

For some years France has been distanced by both England and the United States in the construction of high-speed cruisers, and she does not at the present day possess a single vessel that could be sent against the commerce destroyers Columbia and Minneapolis, and still less against the gigantic English cruisers Powerful and Terrible, whose speed and steaming power make them the rulers of the ocean.

The relative unimportance of her mercantile navy does not demand on the part of France as great sacrifices as would be required from England to protect her commerce. Looking at protection in this light, the Republic would need very few cruisers in time of war. Assuming, however, that she may be involved with another nation possessing a

powerful commercial navy, a different view may be taken of the subject. The destruction of that commercial navy, or more modestly speaking, the crippling of the immense traffic which it is the means of carrying, would be an important factor of success that can hardly be overestimated.

It was such consideration as this that impelled President Faure, then minister of marine, to urge upon the French Chambers the necessity of building a certain number of cruisers with a speed of twenty-three knots, inserting in the estimates a clause providing for the immediate placing on the stocks of two of these vessels. There were some delays in perfecting the scheme, but the awards for the new constructions are by this time in the hands of the Forges et Chantiers de la Méditerranée, and the Société de la Loire, each company to build one vessel from their own design.

The cruisers will be 135 meters long, 16.7 meters beam, with a draught not exceeding 7.5 meters, and a corresponding displacement of about 8200 tons. Their defensive power will consist of an armored deck 50 mm. thick of a polygonal shape, with a cellulated space between this protective deck and the orlop deck, an arrangement lately adopted in the French constructions.

The armament will consist of two guns of 16 cm., six of 14 cm., and ten R. F. of 47 mm. As may be readily seen, the offensive power of these vessels is rather weak, considering their great displacements, but the department sought above all to avoid the construction of enormous and costly ships like the Powerful and Terrible, whose displacements of 15,000 tons are nearly double those of the new French vessels. Given the speed to be attained, and the necessity of great endurance, it became necessary to reduce the armament to a minimum. The installation of an additional gun would have entailed an increase in the displacement, owing to the weight, not only of the gun, but its necessary adjuncts—ammunition hoists, etc.—and also because to keep up the same speed with the extra weight it would be necessary to increase the power, and consequently the weight of the machinery. Finally the coal supply must also be increased if it be proposed to have the same radius of action. In nearly every instance the last two increases, being corollaries of the first, greatly exceed it. It has been calculated that the addition of a 14-cm. gun to the battery would result in an increased displacement of from 500 to 600 tons. Besides, the actual batteries are quite sufficient for the duty for which the vessels are intended, namely, the capture of merchant vessels, fighting mail steamers armed as auxiliaries, or cruisers of their own type.

In general arrangements these vessels do not present any characteristic features apart from their triple screws, three engines, and protection for the 16-cm. guns.

They are protected cruisers with a cellular subdivision (tranche cellulaire), in which the motive power and coal capacity have been greatly increased. The lower parts are entirely taken up by the engines, boilers, and shell-rooms. The engines are placed in one athwartship compartment and separated from each other by longitudinal water-tight bulkheads, each engine having a capacity of 8000 I. H. P. The spaces on each side of the engines serve as water-tanks to feed the boilers. Forward of and abaft the compartment occupied by the engines are the boilers, thirty-six in number, distributed in six athwartship rooms.

The boilers are of the Allest type, with a heating surface of 150 square meters.

Between the protective and orlop decks, in the space forming the cellular subdivision, are distributed the additional coal bunkers, storerooms and supplies of all kinds. On the gun-deck are arranged four search-lights whose low luminous rays pass under the batteries. The 14-cm. guns are in fact placed on the main deck; four of them fire through ports cut in the cants of the redoubt, two forward and two aft; the other two are in sponsons. All of these guns are in casemates, that is, they are worked in the interior of an armored redoubt into which runs an ammunition tube. The bulkheads next the sides have a protective plate of 40 mm., the sides themselves being 60 mm. thick. Finally, the cants, or cut-off angles, being exposed to a more direct fire, have plates 120 mm. thick. Armor shields of 120 mm. revolve with the guns and completely close up the ports.

These arrangements for ordnance of modern caliber seem preferable to installations in revolving turrets. The absence of pivots and machinery renders the redoubt lighter than the turret. Moreover, the space for working the gun is larger, access to the piece is very easy, and finally, a small supply of ammunition may be piled up in the redoubt, which may in a measure obviate a possible mishap to the ammunition tube or hoist. The 16-cm. guns are installed on the main deck, and fire directly ahead and astern, being protected only by revolving shields. No provision is made for fighting tops in these vessels; they will have pole masts like ocean mail steamers, with crow's-nests fitted with search-lights. It is only natural to build vessels intended to prey on the enemy's commerce to simulate ocean mail steamers, and the omission of the military mast is an excellent idea. Captains of cruisers have often complained about their fighting tops, remarking that in war time their vessels would be recognized the instant their military masts showed a little above the horizon, thus making it impossible to deceive the adversary for a single moment. Following the example of the English in the construction of the Powerful and Terrible, the French will give their cruisers stems and sterns similar to those of transatlantic steamers. From a military point of view they will lose in appearance, but in weapons of war the object to be attained takes precedence over all others.

The new cruisers will no doubt be superior in speed to all vessels of a similar class now afloat or in process of building. Their plans of construction and the proportions of their machinery give hopes that the speed of twenty-three knots will be easily attained, if not surpassed.

The Powerful and Terrible were designed for 22 knots, and they may attain that speed; but it must be remembered that experience has demonstrated that in current practice the American commerce destroyers can only exceed that speed when above their load-lines. As to coal capacity, which is of paramount importance to France, who in war time would not possess a single secure coaling station, the new vessels are everything that can be desired. Their bunkers can contain 1500 tons of coal, a quantity sufficient to steam ten thousand miles at a speed of 12 knots, or nearly half the circumference of the globe.

Other projects are before the Bureau Technique, and although it is yet premature to discuss them, sufficient is known to point out some tendencies that are quite interesting. I refer to the increase in the coal-

carrying capacity, and consequent steaming power, the decrease in the importance of armor, and the abandonment of enormous displacements with their extravagant costs.

J. L.

[ITALY.]

VESSELS IN PROCESS OF CONSTRUCTION.

[MILITÄR WOCHENBLATT.]

The following ships are in process of building:

I. Battle-ships, 1st class.—L'Ammiraglio Saint-Bon at Venice, and the Emanuele Filiberto at Castellamare; length 105 meters, beam 21.12 meters, displacement 9100 tons, horse-power 13,500, speed 18 knots, nickel-steel armor of 25 centimeters above, and 15 centimeters at water-line. Battery: 4 B. L. R.'s of 25.4 cm., 8 of 15.2 cm., 8 of 12 cm., 6 of 57 mm., and 4 torpedo tubes.

II. Protected cruisers (battle-ships, 2d class).—1. The sister ships Carlo Alberto and Vittor Pisani; the former at Spezzia, the latter at Castellamare. Dimensions: length 99 meters, beam 18 meters, displacement 6500 tons, 13,000 H. P., 18 knots speed, a 15-cm. nickel-steel armor-belt, two-thirds length along water-line. Battery of twelve (12) 15.2-cm., six (6) 12-cm., ten (10) 57-mm. guns, 4 torpedo tubes. 2. The Garibaldi and the Varese, each 100 meters long, 18.2 meters beam, 6840 tons displacement, 13,000 horse-power, 20 knots speed.

III. Unprotected cruisers.—Puglia and Elba, sister ships. Length 83.2 meters, 12.43 meters beam, 2550 tons displacement, 7000 horse-power, speed 20 knots; armed with four (4) 12.5-cm., six (6) 12-cm., and eight (8) 57-mm. guns.

IV. Smaller vessels.—1. Calabria (fifth class), of Lombardia type. Length 73 meters, beam 12.8 meters, displacement 2470 tons. 2. Governolo (sixth class). Length 56.4 meters, beam 10.23 meters, displacement 1255 tons, 1000 horse-power, 12 knots speed. 3. Caprera (sixth class). Length 70 meters, beam 8.35 meters, displacement 853 tons, 4000 horse-power, 20 knots speed. The batteries of these vessels consist of four (4) 12-cm. and four (4) 57-mm. guns.

[GERMANY.]

TWO NEW CRUISERS.

[DEUTSCHE HEERES ZEITUNG.]

The contracts for the two new cruisers (Ersatz Freya), K and L, allowed by the last session of the Reichstag, will soon be awarded. The specifications show that they are to be of entirely different types from the cruiser Gefion. They are based on the latest types of protected cruisers in the navies of England, United States and Russia. Built entirely of steel, they are unsheathed, which seems to indicate that they will be destined for service with the battle-ships rather than for duty in foreign waters, a supposition that is accentuated by their heavy armaments. The batteries are to consist of 2 21-cm. guns of 40 calibers length in armored revolving turrets; 2 15-cm. R. F. guns of 40 calibers length, likewise in revolving turrets; 4 15-cm. R. F. guns, 40 calibers, in armored casemates; 10 8.8-cm. R. F. guns of 30 calibers length, with gun shields; 10 37-mm. magazine guns, and 4 8-mm. Maxim

guns. These 30 guns, 28 of which are rapid-fire, give a powerful offensive strength, further heightened by 3 under-water torpedo tubes of 45 cm. caliber, one in the bow and two broadside. The strongly arched protective deck extends the full length of the ship. Further protection is afforded by a cofferdam of cork 2.5 meters high, 70 cm. thick, extending alongside over 70 meters in length. There are numerous watertight compartments. The vessels are to have three independent engines in separate compartments. The contract speed will probably be 21 knots, with 10,000 horse-power. The displacement to be from 5650 to 6100 tons. Length 105 meters, beam 17.4 meters, draught 6.25 to 6.61 meters. To be finished in 2 years.

H. G. D.

[ARGENTINE REPUBLIC.]

THE BUENOS AIRES.

[THE ENGINEER.]

The Buenos Aires is a steel ship, sheathed and coppered, and is of the following principal dimensions: Length between perpendiculars, 396 ft., over all 424 ft.; breadth, extreme, 47 ft. 2 in.; and designed mean draught, 17 ft. 7 in., at which her displacement is 4500 tons. Her propelling machinery, which has been constructed by Messrs. Humphrys, Tennant & Co., of Deptford, consists of two sets of four cranked triple-expansion inverted-cylinder engines, having 40-in. diameter high-pressure, 60-in. diameter intermediate pressure, and two 66-in. diameter low-pressure cylinders, all with a piston stroke of 36 in., steam for which is supplied by four single-ended and four double-ended cylindrical return-tube boilers, the tubes being fitted with Messrs. Humphrys' patent ferrules. Owing to the fog on the day of the trials, and the delay occasioned by it in getting the vessel free from her moorings, she had to be put on the measured mile as soon as she was clear of the river's mouth, and before her engines could be got up to their full speed or power. As the conditions of the trial were that the ship should run for six consecutive hours with natural draught, or with not more than ½ in. of air pressure in the stokeholds, and during that time make six runs on the measured mile with and against the tide, it was elected to make the mile runs first, and from them deduce the speed attained during the remainder of the six hours' contract running time.

The condition of the weather having prevented the vessel getting under way as early as was intended, the first two runs on the mile, which were made in 2 min. 47½ sec. and 2 min. 34 sec. respectively, although they exceeded the contract speed, could not be taken as a criterion of what the ship was capable of attaining, as the succeeding four runs were made at a mean speed practically of twenty-three knots an hour. The mile runs being completed, the vessel was then headed south, and the remainder of the contract time run off, the resultant mean speed throughout the whole of it being 23.202 knots an hour. During the running the engines averaged 151 and 151½ revolutions per minute for port and starboard respectively; the mean boiler pressure was 155 lbs. per square inch, the vacuum 28 in. to 29 in., and the total indicated horse-power developed 14,000.

The Buenos Aires is constructed with a steel protective deck throughout the whole of her length, 3 in. thick on its sloping sides, and 1½ in.

thick on the flat parts, the machinery space being protected with inclined armor 5 in. thick. For her size, the ship is very powerfully armed, as she carries four 8-in. quick-firing guns on the upper deck, four 6-in. guns at the ends of the battery, six 4.7-in. guns disposed between each pair of 6-in. guns in the battery, sixteen 3-pounder guns—eight being on the main deck and four on the bridges—together with eight 1-pounder guns distributed in the tops of the two military masts. The ship is also fitted with five torpedo tubes, all above water.

Table Showing Armaments of Ships, Estimates, Rates of Fire and Other Elements. [The Engineer.]

Name of vessel.	Displacement.	Speed.	Armament.	Muzzle energy per gun.	No. of rounds per gun.	Tot'l energy of fire of each class of gun per min.	Tot'l energy of fire per ton displacement	Perforat'n per gun of wrought iron.	Vessel's belt-armor nature and thickness.	Equiv. of belt-armor in wrought iron.
	Tons.	Knots.		Foot-tons.		Foot-tons.	Foot-tons.	Inches.	Inches.	Inches.
Royal Sovereign class ...	14,150	18.0	4 67-ton	35,230	7 in 12 min.	82,203	20.7	34.2	18 compound	22.5
			10 6in. Q. F.	3,356	16 in 3 min.	178,987		16.1		
			16 6-pr. Q. F.	137.5	10 in 1 min.	22,000		3.7‡		
			12 3-pr. Q. F.	80.3		9,640		3.1‡		
						292,830				
Majestic and Magnificent	14,900	17.5	4 12in. 46-ton (wire)	33,940	3 in 4 min.	101,820	26.4	38.5	9 treated	17¾
			12 6in. Q. F.	3,356	16 in 3 min.	214,784		16.1		
			16 12-pr. Q. F.	425	10 in 1 min.	67,680		5.0		
			12 3-pr. Q. F.	80.3		9,636		3.1‡		
						393,920				
Blenheim	9,000	21.6	2 9.2in. 22-ton	10,910	2 in 3 min.	14,547	22.9	22.9	—	—
			10 6in. Q. F.	3,356	16 in 3 min.	178,987		16.1		
			16 3-pr. Q. F.	80.3	10 in 1 min.	12,848		3.1‡		
						206,382				
Powerful and Terrible...	14,200	22.0	2 9.2in. 22-ton	10,910	2 in 3 min.	14,547	21.6	22.9	—	
			12 6in Q. F.	3,356	16 in 3 min.	214,784		16.1		
			16 12-pr. Q. F.	423	10 in 1 min.	67,680		5.0		
			12 3-pr. Q. F.	80.3		9,636		3.1		
						306,647				
Victory in 1805..... ...	2,162	—	30 32-prs.	489.6	Taken at an average of 2 rounds in 3 min.	14,688	—	—	—	
			30 24-prs.	417.2		12,516				
			32 12-prs.	275.1		8,803.2				
			8 12-prs. (short)	182.1		1,456.8				
			2 68-pr. carronades.	699.8		1,399.6				
			2 32-pr. carronades.	426.4		852.8				
						39,716.4				
Buenos Aires..... .	4,500	22.9	2 8in. (45 cal.) Q. F.	10,300	4 per min.	82,400	67.7	26.1	—	—
			4 6in. (45 cal.) Q. F.	4,688	*6 per min.	112,512		20.7		
			6 4.7in. (45 cal.) Q. F.	2,061	8 per min.	98,928		15.2		
			12 3-pr. Q. F.	91.7	10 per min.	11,004		3.1		
						304,844				
Esmeralda.....	7,300	—	—	—	—	526,884	72.2			
Rurik...	10,923	18.0	4 8in.	4,943	2 in 3 min.†	13,181	16.39	15.0	10 compound	12.5
			16 6in.	2,682	1 per min.	42,912				
			6 4.7in. Q. F.	2,061	6 per min.	74,196				
			18 small pieces,	423	10 per min.	42,300				
			taken as 10 12-prs. 8 3-prs.	80.3		6,424				
						179,013				
Russia.....	12,130	20.0	4 8in.	4,943	2 in 3 min.†	13,181	38.84	15.0	—	—
			16 6in. Q. F.	2,356	16 in 3 min.	286,379				
			6 4.7in. Q. F.	2,061	6 in 1 min.	74,196				
			96 smaller Q. F. taken as 20 12-prs. 16 3-prs.	423 80.3	10 in 1 min.	84,600 12,848				
						471,204				

* This gun has an improved breech action, giving higher speed than former patterns. † English energies and rates of fire are used in default of the Russian ones. ‡ Mild steel.

REVIEW.

FACE-HARDENED ARMOR.

We have not had a suitable opportunity up to the present to comment upon a leading review of Lieutenant Ackerman's article in Number 73. The review will be found in full in the *Engineer* of May 24. Among other things it is stated there that "we are unable to accept his conclusions, which, in our judgment, lead to the substitution of rather a complicated and confused theory, and one which does not accord with results recorded, instead of the present one which is clear and on the whole fairly established. The main subject of the paper is the action of hard armor on shot striking it. Hitherto it has been supposed that a hard and well-supported surface resisted the shot before its point got deep enough in to receive support, and thus it frequently caused fracture or distortion of the shot. In this way the chilled iron shot formerly employed with such success against wrought iron broke almost like snowballs against the first steel-faced armor, and had to give place to steel projectiles."

The reviewer failed to note that Lieutenant Ackerman was not describing the action of chilled iron shot, but of the steel projectiles which took their place. In fact the effect of the typical face-hardened plate upon the projectile varies with the latter's quality. The conclusions of the essayist were based upon the results of hundreds of impacts of the best quality of modern armor-piercing projectiles, and to attempt to discredit those conclusions by citing the behavior of the inferior chilled iron shot seems absurd.

"Lieutenant Ackerman remarks that Captain Tresidder refers to 'data which he has seen fit to withhold,' which, he says, are widely different from the experience obtained in the States. It would be wrong to contradict this without knowing what experience is referred to, but we submit that Lieutenant Ackerman gives us no results in support of what he says. So far as we know, the results of trials in all countries bear out Captain Tresidder's explanation; and Lieutenant Ackerman's difficulty about what he calls the 'mashing of fragments in the indent' would, we think, be removed if he had had more experience with the earlier and inferior projectiles employed, when he would have seen what he regards as inexplicable realized *ad nauseam*."

Here again the conclusions derived from numerous experiments with *bona fide* modern shells and armor are rejected in favor of those derived from the distantly analogous behavior of "the earlier and inferior projectiles employed." The photographs and descriptions of the four shells opposite pages 42 and 50 in the essay certainly support the writer's contentions. These shells are not isolated examples; they are typical of the behavior of all modern shells of their class and quality. Two of them are entirely too weak; it will be noticed, however, that

the method of failure is not that described by Captain Tresidder and commented upon on page 50 of the essay. It will be noted that in the photographs noted the principal cracks are longitudinal and spiral, the points are abraded or fused, and the surface of the ogival flaked away; but the planes of cleavage do not at all agree with those described by Captain Tresidder. On page 44 of the essay is given a description and sketch showing the method of the failure of an ordinary very hard armor-piercing shell, such as was found very successful against oil-tempered steel armor. Many of these heads of projectiles have been shaken out of the plate by subsequent impacts, permitting a close inspection.

"Lieutenant Ackerman adds that the usual action of the hard face, however, is 'that through its inability to bend or flow, it prevents the displacement of the more plastic metal beneath it towards the front, and thus brings the resistance of the whole thickness of the plate to bear before the projectile can advance.' That is to say, the shot is not able to squeeze the metal up in a lip around it as it enters. It is true that this lip is not formed in hard-faced armor. Lieutenant Ackerman has done good service in calling attention to this, which has not been sufficiently noticed, perhaps; but we lay very limited stress on it, because compound or steel-faced iron plate formed no swell or bulge round the point of impact, and yet this armor was easily perforated until it had its face treated on Tresidder's process, when the projectiles were defeated and broken up. Those who have followed the course of experiments in this country can hardly fail to agree with Captain Tresidder's description of the phenomena exhibited in perforation."

The results of experiments on *bona fide* face-hardened armor are again discredited in favor of those obtained with inferior projectiles and obsolete compound armor. As the steel face of compound armor referred to contained about 1 per cent. of carbon, little, if any, flow of metal could occur in it. This lack of elongation, however, made it incapable of absorbing much energy; it cracked through under impact, and being held to the soft back only by a defective weld, was easily displaced and flaked off. The abrupt combination of the brittle hard face and extremely soft back was disadvantageous, for the two parts failed separately; the face having cracked away before the back had elongated to the point of maximum tenacity. The same is true of the compound plate when water hardened, only in that case the superficial hardness had been greatly increased and the remaining metal in the steel face had been improved and perhaps toughened. The method of resisting was really the same; no change had occurred in the back, but the resistance of the face had been increased, and it required a better projectile to perforate it. As the front third of the plate was, as before, of high carbon steel, it could not flow anyway, so it can hardly be said that it bottled up the resistance of the plate by preventing a forward displacement of the metal. In both cases, however, of the water-hardened and the untreated compound plates, the rigid face, when not displaced or flaked off, increased the resistance of the wrought-iron back by preventing the metal displaced by the projectile flowing to the front. When the hard face was displaced, concentric waves or bulges of the iron back were almost invariably found around the impact, showing that the soft metal had moved to the front in the direction of least resistance. Water tempering undoubtedly improves the tensile

and compressive strength of the face of modern face-hardened armor enormously; in addition, it has greatly improved and toughened the metal in the body of the plate. A great deal of space has been given by Lieutenant Ackerman in the essay to these points. It will be noticed, however, that he has explained the resistance of the plate by describing the combined effect of a face of very great compressive strength with a strong and tough body. Necessarily this creates a complicated and difficult theory. It is very easy to say with the reviewer that the hard face breaks the projectile up from the point, and that the present theory "is clear, and on the whole fairly established"; but it may be asked, is not the present theory, requiring as it does not only a definition of *hardness*, but a full comprehension of the mutual behavior under impact of bodies of *unknown relative hardness*, far more difficult than the one proposed in the essay? F. Auerbach, in *Annalen der Physik und Chemie*, April, 1891, states that the subject of hardness "in its broader bearings has not yet been attacked with success, nor has a rigorous definition of hardness been established. . . . The edge of a rapidly rotating, relatively soft disc is scarcely touched by a file or lathe tool, and that if the motion be rapid enough, it is the tool which suffers most. . . . Hardness, when determined by scratching, is much too complex a conception to be used as a basis for the definition of the property. Complications are introduced by the motional phenomena, the lateral sheer which accompanies scratching, and in short, by conditions which have nothing to do with hardness." It is difficult to see how any theory involving a full comprehension of the property of hardness can be "clear" to any but the most easily satisfied and superficial of readers.

Again, "we believe that the real value of the cap is to prevent the fracture of the shot's point, and this has been endorsed, so far as we know, by facts; the matter, however, is easily brought to the proof. If Lieutenant Ackerman is correct, the value of a cap simply depends on whether the plate has a hard face which will not bulge or flow, while we believe that a shot which is able to hold together on impact will not benefit by a cap."

The four photographs of typical projectiles previously referred to support Lieutenant Ackerman's contention. Even in the case of the capped projectile which perforated the plate, the striations produced by the fragments of the hard face are plainly visible. In shell No. 262 the hard face was carried into the plate, enveloping the excellent point which escaped injury. The upsetting of the shell and the intense compression farther back where the most of the friction occurred, caused flakes of metal to be sheared off and the shoulder to be deeply scored. This shell held together, and would doubtless have done better with a lubricating cap. In the case of shells No. 160 and No. 15, it is plainly apparent that the points would not have been benefited by caps. These shells penetrated deeply, but the plate was able to absorb all their energy and stop them. Their points have been fused, abraded and twisted, but they certainly were not pulverized from the point. The results of many armor tests in the United States have been published with the photographs of projectiles which had perforated face-hardened armor, and it is a very common thing for a shell to hold together and perforate, although the abrasive action of the hard face wears the ogival down to a hemisphere.

"If Lieutenant Ackerman is correct, however, results ought to be forthcoming in support of his theory. For example, we witnessed certain Holtzer projectiles fired at untreated nickel-steel at Indianhead in 1893. These yielded and set up in a bulge round the projectile, at about half-way down, where the walls were apparently weakest. These projectiles might probably be made to set up and behave in the same way against treated armor, and if they could be made thus to behave, they ought, according to Lieutenant Ackerman, to benefit by having iron caps put on them. We shall be greatly surprised if shot so behaving can benefit by the addition of a wrought-iron cap. By all means let such a result be produced, as it will go far to establish our author's theory."

If the shell sets up or expands it will fail to perforate a face-hardened plate unless its energy greatly overmatches the resistance of the plate. In that case the shell would go through anyway. If the shell stops, however, the lubricant is of no use, for there is no friction. It does not appear that Lieutenant Ackerman states anywhere, inferentially or otherwise, that a cap would assist an expanded projectile in any other way than it assists one that retains its shape, that is, by "covering the asperities of the hardened metal." To be of any value motion is necessary.

"If the metal of the cap could be substituted for so much rigid metal round it in the plate, we should see a great benefit; but seeing that however it may accommodate itself to the hard fragments, the shot has to cleave its path open to the full size of its caliber, it may be doubted if the cap has helped it much."

This statement would seem to indicate a disbelief in the value of lubricants. From the table of tests with capped projectiles on page 52 it appears that the cap is of no appreciable value except when the uncapped shell would barely fail to perforate; the capped shell gets through merely because it is lubricated.

"We must now pass to Lieutenant Ackerman's proposal to employ armor plates with 'gashes' and ridges made in them, so as to facilitate cementation, and 'permit deeper chilling in hardening.' We may admire the inventor's defense of his proposal, which is too elaborate to give here, but we know the result we expect to follow. Projectiles may be broken up by such plates under favorable conditions, but the plates will fly into fragments; nay, we are tempted to say into 'smithereens,' as more expressive. Whatever result may be produced on the first shot, then we should anticipate that the structure will be stripped bare of its armor very rapidly; in fact, in spite of having learned much from the United States, we do not anticipate any future for 'gashed' plates."

It would have been well for the reviewer to have added: "The proof of the pudding, however, lies in the eating of it." On August the 13th last, a "gashed" plate 7 inches thick was tested at the Naval Ordnance Proving Ground. Fully 40 per cent. of the face was cut away at the points of impact by the gashes, which were about 1 inch deep. The plate did not represent in many important respects Lieutenant Ackerman's wishes. In the first place it had been over-carbonized, and the ridges were brittle hard through and through. It had been his intention, moreover, to forge the ridges down in the case of such thin plates. There were also other objections to the plate which had been made to test the feasibility and advantage, if any, of the various changes in

the manufacture proposed, rather than to represent the ballistic value of the process. As a result, the methods proposed for a thick plate were applied to a thin one; nevertheless the plate, in spite of its disadvantages, behaved excellently, and compared very favorably with service plates of the same thickness. Two excellent 6-inch 100-lb. armor-piercing shell were fired at the gashed portion of the plate, one with a velocity of 1816 ft. s., and the other with a velocity of 2100 ft. s. The first penetrated about 5".5, the second got its point through to the shoulder. Far from flying into fragments, the plate was not even cracked. A few fine hair cracks appeared in the hard surface in the immediate vicinity of the impacts, but the actual damage was confined to the closely circumscribing group of gashes.

The projectiles were excellent, as was shown by the fact that, although somewhat cracked, they were not crushed, remaining in the plate with their bases projecting.

BIBLIOGRAPHIC NOTES.

[AMERICAN.]

AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER. The United States Cruisers Columbia and Minneapolis. H. M. S. Powerful. Aeronautics: the War Kite.

OCTOBER. Machinery for the New United States Torpedo-boats. Naval and Marine Notes. Aeronautics: Aeroplane Stability during Flight.

After November 1 the *American Engineer* will be published bi-weekly. Each number will contain one-half as much reading matter as is now contained in the monthly issue. The annual subscription rates will be reduced also.

NOVEMBER 1. The United States Battle-ship Indiana.

IRON AGE.

SEPTEMBER 12. A New Translucent Fabric.

OCTOBER 10. The Playford Stoker.

NOVEMBER 14. An Experimental Test of the Armored Side of U. S. S. Iowa.

NOVEMBER 28. The Improved Gatling Gun. The History of the Lathe.

DECEMBER 5. Report of the Secretary of the Navy.

DECEMBER 12. The Russell-See Electric Indicator.

This consists of a simple electric indicating and controlling mechanism which, when used on a vessel, will at all times keep the deck officer informed of the condition of his running lights.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

SEPTEMBER. The Army and the Civil Power. The Efficient Handling of Sea-Coast Artillery in Action.

The author handles this subject well from his own standpoint. He neglects the fact that the initiative will rest with the fleet, and that in case of a night attack the position of the fleet may be practically unknown, while that of the fort or forts is fixed. It may be assumed, as in serious attack of other defenses, that the attacking force will be much the stronger. Fog in these days of torpedo-boats and destroyers to act as scouts will not be an insuperable obstacle. It appears, however, that much will be expected of the fleet, but hardly more than

will be expected of the sea-coast artillery, if it count on reproducing against a vigorous, intelligent enemy anything like the results of peace target-practice.

Any such accurate weapon as the 12" B. L. mortar will probably be found in the fleet, and will be properly utilized against the land defenses. With high angle fire, in the neighborhood of 45° elevation (or other angle corresponding to maximum range), a degree more or less of elevation due to the roll of a ship will not cause much error, and the weight of the charge which determines the range is as controllable on sea as on land.

At the same time we heartily approve of coast defenses and accurate coast artillery fire. They cannot stop invasion, but may prevent bombardment of cities on the seaboard by ships; they will have a deterrent effect in any case, and are excellent as bases. Their value with a proper mobile force to act with them would be similar to that of Mantua in Napoleon's Italian campaigns. Napoleon says, "It is on the open field of battle that the fate of fortresses and empires is decided." He might have added after "battle," in view of his own fall, "*on sea or land.*"

Fortifications and Field Operations. Our Present Artillery Armament. The Man behind the Gun. The Bicycle as a Military Machine. Martial Law in Ceylon. Recruiting and Training of the Company. Modern Infantry Tactics. Modern War Conditions. Organization of Artillery Masses. Shock Power of the Service Bullet. Military Notes.

NOVEMBER. Can West Point be made More Generally Useful?

"Pursue this course: raise and keep the standard of admission to the Military Academy to the level of public school advantages throughout the land, thereby diminishing the number of cadets who fall by the wayside after entrance, while correspondingly increasing the number of graduates."

Extended Order. Military Education for the Masses. Artillery Organization. Military Reservations. The Bicycle for Military Uses. Ammunition Packing Boxes. The Equine Toilet. The Evolution of the Art of War. Twenty Years of Tactical Evolution in Germany. Examination for Promotion in England. German Theories upon the Utilization of the Local Resources by Troops in Campaign. The German and French Manœuvre Armies Compared.

JOURNAL OF THE UNITED STATES ARTILLERY.

JULY. Experiments with a New Polarizing Photo-Chronograph applied to the Measurement of the Velocity of Projectiles. The Development of a Naval Militia, by Jacob W. Miller, Commander, Naval Battalion, New York. Proposed Modification of the Field Gun Sight. Coast Artillery Fire Instruction. Light Artillery Target Practice.

OCTOBER. Experimental Use of the Essick Page Printing Telegraph for Transmitting Information in Sea-coast Artillery Firing, 1895. Notes on Confederate Artillery Service. Artillery Projectiles and their Penetration. Coast Artillery Fire Instruction. Note on a Photographic Method of Determining the Complete Motion of a Gun during Recoil.

ENGINEER. [FOREIGN.]

JULY 26, 1895. Steam-Pipe Safety Valve. An Improved Siren. French War Vessels.

This article, while strongly condemnatory of the Hoche and Dupuy de Lôme, approves of the excessive "tumble-home" of their sides. Speaking of this latter and in regard to the British constructions, it says: "By its adoption, the side armor could be carried to a great height without seriously altering the metacentric features, and more effectual protection given to the gun's crews—a most important attribute in this day of rapid-fire warfare."

AUGUST 30. The Coast Defense French Battle-ship Bouvines. Trial Trip of the Russian Torpedo-boat Destroyer Sokol. Double Turrets for American Warships. [This article is a copy of that in the Army and Navy Journal.]

SEPTEMBER 6. The United States Naval Proving Ground at Indian Head. United States Experiments with a Polarizing Photo-Chronograph.

SEPTEMBER 13. Coal Consumption of H. M. S. Magnificent.

The results of the trial showed that with a mean of eighty-two revolutions of the engines per minute, maintained with a pressure of 133 lbs. per square inch in the boilers, the engines developed 6086 indicated horse-power, the coal consumed per horse-power per hour being 1.67 lbs. The boilers throughout the trial (of 30 hours' continuous duration) were worked with natural draught.

The Russian Torpedo-boat Destroyer Sokol.

OCTOBER 25. Launch of H. M. S. Victorious. H. M. S. Majestic.

The length of the Majestic between perpendiculars is only 390 ft., but, including the massive ram bow, which projects to a distance of 15 ft., and the hang-over of the stern and gallery, the total length over all is about 430 ft. The beam is similar to that of the Royal Sovereign class—75 ft. Hence the increased length has improved the speed of the new vessels, 17.8 knots per hour having been obtained with the Majestic, although the indicated horse-power is actually 1000 less than in the battle-ships of the 1889 programme. The displacement is 14,900 tons, exceeding that of any battle-ship afloat. The performances of the Majestic during her thirty hours' continuous trial were most satisfactory. Steaming gently, without any break, at an average rate of horse-power of 6075, she covered 440 knots in thirty hours; while, for every indicated unit of horse-power, she consumed only 1.84 lb. of coal per hour.

NOVEMBER 1. Steering Engines in the Royal Navy. Leading Articles: The Funnels of Warships; Coppering the Bottoms of Steel Ships. "The New Centurion," Longman's Magazine.

NOVEMBER 8. The Belleville Boiler and its Evaporative Efficiency. The Hanging of Harveyed Armor-Plates. Speed Trials of the New Argentine Cruiser Buenos Aires.

NOVEMBER 15. New Designs in Warships and Ordnance.

Advocates the introduction of the 8-inch B. L. R. into the British service in place of the 9.2-inch; as it is capable of being worked by hand-power, and marks the limit of the rapid-fire principle.

NOVEMBER 22. Launch of H. M. S. Jupiter.

ENGINEERING.

JULY 12. The Laws of Similitude as Affecting Naval Construction. On Water-Tube Boilers, by J. A. Normand.

AUGUST 2, 16, 23, and SEPTEMBER 6. The North-East Sea Canal.

SEPTEMBER 6. The Electric Lighting of the Entrance to New York Harbor. Coast Defense Artillery for Sweden and Norway [Whitworth 24 and 28-cm. guns]. Welin's Breech-loading Mechanism.

SEPTEMBER 13. The Sokol. Welin's Breech-loading Mechanism.

The threaded segments of the breech-block are arranged so that each successive segment has a radius larger than the preceding one, all but two out of eight being threaded. For a 10-inch B. L. R. there are twelve segments, ten being threaded. This construction makes the breech-block lighter.

SEPTEMBER 20. A New Smokeless Powder (Maxim-Schupphaus).

SEPTEMBER 27 and OCTOBER 18. The French Naval Manœuvres.

NOVEMBER 1. The Sokol (with illustration).

NOVEMBER 8. The Argentine Cruiser Buenos Aires (with photographs). The Work of Technical Societies. The Torpedo-boat Destroyers.

NOVEMBER 15. The United States Cruiser Minneapolis (illustrated). The Production of Modern War Material in the States.

NOVEMBER 22. The Torpedo-boat Destroyers Rocket, Shark, and Surly.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

AUGUST. The Royal Naval Reserve.

SEPTEMBER. On Torpedo-boat Destroyers. Kites: their Uses in War.

The conclusions of the author as published in the United Service Gazette were given in the last number of the Proceedings. The discussion following the lecture was not entirely favorable to the use of kites. Properly developed, they have undoubted value for naval purposes.

The Proposed Atlantic-Mediterranean Canal. Albuera.

OCTOBER. Water-Tube Boilers. The Colors of the Royal United Service Institution. The 14th Light Dragoons at Chillianwalla. The New Russian Armored Cruiser Rurik, with profile and deck plans.

NOVEMBER. Blockade in Relation to Naval Strategy, by Captain Mahan, U. S. N. Electric Propulsion and the Naval Service (translation).

The naval and military notes accompanying each of the above-mentioned numbers are very full, and are particularly interesting and instructive. In his various notes and reviews, the editor shows himself a keen and competent critic.

STEAMSHIP.

AUGUST, 1895. Another Unsinkable Boat.

Two short arms on each side of the boat, hinged at the water-line (for vertical plane movement), are kept ordinarily up the side of the boat and hold at their upper ends a suitable tube float. Two bent arms on each side, weighted at the ends, are similarly hinged at the gunwale, and by falling over the tube hold it to the side. If the boat capsizes, the float is free to move out from the side, and is prevented from going too far by a toe on each of the first-mentioned arms.

SEPTEMBER. Transmission of Electrical Power on board Ship.

For refrigerators, pumping and winding, auxiliary machinery, steering engines, capstans, ash-hoists, ventilating fans, ammunition lifts, training mechanism for guns, closing water-tight doors, air compressors for torpedo tubes. No design is given for an electric handy-billy.

OCTOBER. Launch of H. M. S. Venus. Steam Steering Engine for H. M. S. Venus. Speed Trials (contractor's) of H. M. S. Magnificent.

The speed was measured by log. The results for a four-hours' trial were: starboard engine 6002, and port 6155 indicated horse-power, vacuum 26.0 and 26.6; revolutions 99.8 and 100.8; speed 17.6 knots.

TRANSACTIONS OF THE NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

VOL. XI. Theory of the Rolling of Ships. Ship Acceleration and Fluid Resistance. The Transmission of Power by Electricity. The Application of the Electric Arc to Machinery and Boiler Repairs.

UNITED SERVICE GAZETTE.

JULY 13, 20 and 27. Types of Warships. [A consideration of a few of the types represented at Kiel.]

"The New York, which, notwithstanding the serious doubts the *Times* correspondent heard expressed on the point, may, we think, be assumed in all probability to be sufficiently stoutly built, is, in his opinion and in that of most naval critics, no unequal match for the Rurik. True, there is no armored protection immediately beneath either the turrets or barbettes of the New York; but, though the direct protection of the guns is deficient in some respects, it is far greater than in the Rurik."

JULY 27. The Shock Power of the Service Bullet.

It seems extremely doubtful whether the service bullet, small caliber, will give a sufficient shock to "stop" a man or horse.

AUGUST 17. The Naval Manœuvres (British).

AUGUST 24. Launch of the Prince George. The United States Cruiser Columbia.

The time of the run from the Needles to Sandy Hook was 6 days 23 hours 49 minutes. At the time of departure the quantity of coal on board was 1861½ tons, the draught forward was 26 feet 3 inches, aft 25 feet 6 inches. The total coal consumed was 1474 tons 1180 lbs.

The Recent Naval "Tactical Exercises."

"Previous naval manœuvres, with the partial exception of those of 1891, have always been of a strategic character. . . . It is now perceived that the so-called 'misconduct' which was punished with extreme severity in the earlier part of several eighteenth-century wars was not due, as was supposed, to want of loyalty or want of courage, but to insufficient acquaintance with the methods and principles of tactics and the defective signalling arrangements of the age. In the latter connection it is eminently satisfactory that a special effort was, during the recent 'exercises,' made to definitely ascertain the best methods of distant signalling. The rapidity with which modern vessels move renders this a most important point.

"One special lesson which the 'tactical exercises' just brought to a conclusion would seem to have demonstrated is, that vessels of very varying classes can be manœuvred together with far greater success than could have been reasonably expected."

SEPTEMBER 14. A New Polarising Photo-Chronograph (continued from the two previous numbers). Further Trials of the Sokol. Science in Warfare (Captain Sir Douglas Galton, K. C. B., in address as President of the British Association).

"But, great as have been the developments of science in promoting the commerce of the world, science is asserting its supremacy even to a greater extent in every department of war."

OCTOBER 12, 19. The Evolution of the Blue-Jacket (Vice-Admiral P. H. Colomb in the North American Review).

OCTOBER 26. The Trafalgar Anniversary. Launch of the Victorious. Proposed Emergency Ration for the American Army. Trafalgar's True Teachings.

NOVEMBER 23. The Problem of Modern Blockade. [A discussion of Captain Mahan's article in the Journal of the R. U. S. I.]

J. H. G.

LE MONITEUR DE LA FLOTTE.

AUGUST 31. The Japanese Victories.

"When, a year ago, the news of the battle fought off the mouth of Yalu was flashed all over the world, officers, writers, and publishers interested in naval affairs discussed the merits of that naval combat and sought in them logical lessons. This was, indeed, the first time that two fully equipped fleets met in action since the adoption of modern warships and armaments. It is just possible that an anxious desire to find in this battle profitable lessons for the future may have caused some to exaggerate the importance of its results, for neither side having fired high explosives, as wouldn't be the case with European navies, it is made clear that the lessons derived are far from conclusive.

Nevertheless, very interesting data have been gathered: the various incidents of the battle and the damages to the vessels engaged have demonstrated beyond a doubt the necessity of speed, in a tactical as well as in a strategic point of view, the efficiency of the quick-fire gun and the necessity of protection against its projectiles. Finally, it is shown that the navy of the Mikado possessed the qualities that make really efficient fleets, as well as able commanders, well-educated officers and efficient crews."

SEPTEMBER 7. The Sailors of the Imperial Guard.

An interesting memoir upon the naval battalion created by Napoleon I. as his body-guard at the time of the projected invasion of England.

SEPTEMBER 14-28. How to Make Ready for War. The Submarine Cables.

"What would be the situation in the case of a war breaking out suddenly between England and France is the momentous question agitating the minds of the French naval people."

OCTOBER 12. Names of the New Warships; New Constructions for 1896.

The programme includes an appropriation of 95,155,624 francs, the largest yet in any year. The Government will build six first-class battle-ships, one armored coast-defense, two first-class cruisers, five second-class cruisers, three third-class cruisers, one torpedo cruiser, two foreign station despatch boats, one despatch transport, one submarine boat—twenty-two vessels in all. To private yards will be awarded the construction of 3 battle-ships, 2 armored coast-defense vessels, 3 first-class cruisers, 4 second-class cruisers, 2 third-class cruisers, 2 high-speed cruisers, 1 torpedo-boat transport cruiser, 2 torpedo catchers, 2 gunboats, 1 torpedo despatch-boat, 5 sea-going torpedo-boats, 7 first-class torpedo boats, and 5 embarkable torpedo-boats.

The above programme has since been modified.

NOVEMBER 2. Battle Tactics.

"Noticing the absence in the navy of a prevalent fundamental principle (doctrine) in battle tactics, M. Marc Landry is of opinion that it would be expedient to fix upon invariable principles to serve as a basis for fleet commanders when making their final preparations for battle. There must be, he says, a certain set of common ideas, more or less general, enabling all those called upon to take part in an action to judge of the situation in the same spirit, to foretell the manœuvres of their colleagues, and as a consequence, to work with them in the prosecution of a common object, with a perfect understanding obtained without the necessity of signals. There are so many different opinions in regard to preparations for battle that it becomes an absolute necessity to rest upon well defined principles from which to deduce battle tactics, to be improved upon day after day by experience, until a solution is obtained that will be found nearest the truth. We humbly confess that such an ironclad doctrine does not appear to possess a positive advantage, and will still adhere to the well known principle of Nelson, that 'a commander will be always at his post when alongside of an enemy,' or Villeneuve's when he said that 'any captain not under fire is not at his post.'"

NOVEMBER 23. A New Press Campaign in England in Favor of an Increase of the Navy.

"It is very likely a repetition of the campaigns of 1888 and 1893, with the same object in view." Speech of M. Lockroy, the new minister of marine, to the personnel of his Department.

REVUE DU CERCLE MILITAIRE.

AUGUST 31. Cyclists as Cavalry Auxiliaries.

SEPTEMBER 7. Infantry, and the Artillery Duel.

SEPTEMBER 14. Army Group Manœuvres (map). Infantry, and the Artillery Duel (cont.).

SEPTEMBER 28. Reforms in the War Office.

OCTOBER 5. How to Court Defeat (a study). Reforms in the War Office.

OCTOBER 12. A Comparison between the French and German Grand Manœuvres.

OCTOBER 19. The Folding Bicycle at the Grand Manœuvres of 1895. The New Fire Drill Regulations. Manœuvre of the Medical Service Corps.

OCTOBER 26. How to Court Defeat (cont.). The Folding Bicycle at the Grand Manœuvres of 1895. Manœuvre of the Medical Service Corps.

NOVEMBER 2. Garrison Manœuvres for Officers of the Reserve and the Territorial Army. The Folding Bicycle, etc. (with map).

NOVEMBER 9. Opinions of a Russian Officer about the French Army. Coast Defenses. The Folding Bicycle at the Grand Manœuvres (with map) (ended).

NOVEMBER 23. The New German Cavalry Regulation (see also Nov. 16). Military Hygiene.

REVUE MARITIME ET COLONIALE.

SEPTEMBER. On the Advantage of a Systematic Reorganization of the Naval Establishment. On the Stability of Small Vessels in a Heavy Sea. Statistics of Wrecks and Other Sea Mishaps for the year 1893 (cont.). A Study of the Laws of Storms.

OCTOBER. A Study of the Electric Gyroscope. Grave Defects of High Speed Cruisers. The Grounding of the Sardegna. Opinion of an Officer regarding the Raleigh and Cincinnati.

Not efficient war vessels. Intense heat in their fire-rooms. Too much machinery; too little coal; crews' berthing inadequate.

NOVEMBER. The Italian Colonies. Circulation of Winds and Rain (supplementary and explanatory notes) (ended). Influence of Sea Power on History (1660-1783) (cont.), translated from the English).

LE YACHT.

AUGUST 31. **Modern Naval Tactics: Opinions of the English** Press. (Lieut. Leplay, of the French Navy, published *in extenso* an article on the above subject in the Revue Martime et Coloniale (1895)).

SEPTEMBER 7. Modern Naval Tactics (see preceding No.). The America's Cup. Organization of the Transport Service between China and Indo-China.

SEPTEMBER 14. Modern Naval Tactics: Opinions of the American Press.

SEPTEMBER 21. Experimental Determination of the Least Resistance Form of Hull.

SEPTEMBER 28. The New 23-knot Cruisers, and the Next Naval Constructions. The Question of Auxiliary Transport Vessels. Experimental Determination of the Least Resistance Form of Hull. The Cost of Warships in England. Perception of Phonic Signals.

OCTOBER 5. The 31 Knots of the Twin Screw Torpedo-boat Forban (a detailed account of the official trials). The First-class English Cruiser Terrible.

OCTOBER 12. The Net Cost of Warships in England. The Armored Coast Defense Vessel Sachsen, of 7438 Tons. The English First-class Cruiser Terrible.

OCTOBER 26. The New Torpedo-boats and Torpedo Catchers.

NOVEMBER 2. The Naval Reforms.

NOVEMBER 9. The Navy Estimates, by Marc Landry.

NOVEMBER 16. The Navy Reforms and the New Administration.

RIVISTA DI ARTIGLIERIA E GENIO.

JULY-AUGUST. Method of Sighting and Pointing in Coast Batteries. Training of the Personnel of Coast Artillery. The New Disinfecting Establishment at Hamburg.

SEPTEMBER. Notes on the Fire Drill of Field Artillery. A Note upon the Manner of Removing Incrustations in the Interior of Drinking Water Pipes.

OCTOBER. Correction for Each Piece of the Distance obtained by the Range-Finder in Coast Firing. The Automatic Tangent Scale. About Armor Plates and their Behavior under Fire.

RIVISTA MARITTIMA.

OCTOBER, with Supplement, and NOVEMBER. The Sailing Routes of the China Seas. Maritime Meteorology. The Side Keels for Large Ships. Tactical Use of Torpedo-boats. The Military Situation in the Mediterranean.

REVISTA TECNOLÓGICO-INDUSTRIAL.

AUGUST. Applications of Cinematic Geometry; The Mathematical Infinite in the Direct Acting Steam Engine. Altimetry; Measuring Altitudes by Means of the Barometer, Hipsometer, and Photogrameter. The Heights of Many Spots in Catalonia.

BOLETIN DO CLUB NAVAL.

AUGUST 30. Coast Defenses (cont.). Feed-Water for Boilers. Gas Pressure of Powders in the Chamber of the Gun. Determination of the Temperature of Combustion of Explosives. Submarine Photography.

BOLETIN DEL CENTRO NAVAL.

JUNE-JULY. The Projected Dockyard at La Plata. Compulsory Military Service (considerations on which is founded the project). Brief Historical Notes on Modern Naval Warfare. Steel for Ordnance (cont.).

AUGUST. The Cruise of the Argentina; a Glorious Page in the Argentine Naval History. The Naval Fêtes at Kiel. Remarks on Battle-ships, Cruisers and Guns. Installation of Krupp Guns of 28 cm. in the Bays of Valparaiso and Talcahuano. Destroying the Felix Patagonia Reef that obstructed the Channel of the Riachuelo. J. L.

DEUTSCHE HEERES ZEITUNG.

SEPTEMBER 14. The New Cruisers (Ersatz Freya) K and L.

SEPTEMBER 18. The Offensive and Defensive Weapon in the Battle of the Yalu. Determination of the Fighting Value of a Vessel (method of Captain Bettolo, of the Italian Navy).

SEPTEMBER 28. Carrier Pigeons.

Experiments were recently conducted in Sweden to discover whether the noise and concussion of the guns during a naval engagement have any effect upon the carrier pigeons, especially upon their localizing powers. It was shown that, during or even shortly after a heavy cannonade, the liberated birds failed to take up their flights, and were evidently so stunned as to incapacitate them for some time. The importance of this point must not be neglected in dealing with the question of carrier pigeons.

MARINE RUNDSCHAU.

OCTOBER, 1895. Necessity of Regular Physical Exercises for Naval Officers.

Dwells on necessity of physical exercise. A horizontal bar and parallel bars can be easily set up on board ship. Daily exercise is needed; also jumping. Apparatus easily rigged on deck. Fencing with foil and broadsword. Dumb-bell and Indian club exercises are recommended above all others; can be easily carried out on board ship. Riding on horseback and bicycle, rowing and swimming, long-distance swimming, and swimming fully clad is recommended. Walking, mountain-climbing, running.

Fog Signals Indicating Course of Vessels.

A review of the different forms of delivering fog-signals to indicate courses steered. A satisfactory solution of the problem has not yet been obtained. It is difficult to decide which of the systems is the best, that embodying a combination of short and long blasts for different quadrants, or that containing a combination of blasts in different keynotes, such as bass and treble. The most difficult point will always be the determination of the direction and distance of the signalling vessel. Until this determination is accurately established by some invention, the use of fog horns, sirens and whistles to indicate courses steered will be limited.

NOVEMBER. The Education and Assignment of Specialists from the Corps of Naval Officers. Estimating Distances.

MILITÄR WOCHENBLATT.

SEPTEMBER 7, 1895. Africa: Some Observations on the Effects of Bullets from the Military Rifle M/88.

In two cases where horses were struck without injuries to vital parts or bones the wounds healed very rapidly. In both cases the wounds caused by exit of the bullet were but slightly larger than those of entrance. And it appears that if the bullet pierces soft parts, without touching nerves or larger blood-vessels, it will leave the body in same shape and size as in entering. Also in hunting large game it was found that unless struck in the head, heart, backbone or bones of the legs, the bullet is insufficient to stop the game. Even with shots through lungs, body, etc., larger animals are able to run for great distances after being struck, and frequently get away.

OCTOBER 5. New Italian Warships.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXIII., No. 10. Progress in Armor and Ordnance during 1894 (Karl Pfeiffer, Lt. of Artillery). III. Artillery in the Battle of the Yalu. H. G. D.

REVIEWERS AND TRANSLATORS.

Lieut. J. H. GLENNON, U. S. Navy. Lieut. H. G. DRESEL, U. S. Navy.
Prof. JULES LEROUX.

EXCHANGES.

American Chemical Journal.
American Engineer and Railroad Journal.
Army and Navy Journal.
Army and Navy Register.
Bulletin of the American Geographical Society.
Bulletin of the American Iron and Steel Association.
Bulletin of the Geographical Society of California.
Cassier's Magazine.
Colliery Engineer.
Electrical Engineering.
Engineer (New York).
Engineering-Mechanics.
Geological Survey of Missouri.
Iron Age.
Journal of the American Society of Naval Engineers.
Journal of the Association of Engineering Societies.
Journal of the Franklin Institute.
Journal of the United States Artillery.
Journal of the United States Cavalry Association.
Journal of the Military Service Institution of the United States.
Lend-a-Hand.
Littell's Living Age.
Occasional Papers of the California Academy of Arts and Sciences.
Proceedings of the American Philosophical Society.
Railroad Gazette.
School of Mines Quarterly.
Scientific American.
Stevens Indicator.
Technology Quarterly and Proceedings of the Society of Arts.
Transactions and Proceedings of the Geographical Society of the Pacific.
Transactions of the American Society of Mechanical Engineers.
Transactions of the American Institute of Mining Engineers.
Transactions of the American Society of Civil Engineers.
Transactions of the Connecticut Academy of Arts and Sciences.
Transactions of the Technical Society of the Pacific.
United Service.
Annalen der Hydrographie und Maritimen Meteorologie.
Boletin del Centro Naval.
Boletin do Club Naval.

Deutsche Heeres-Zeitung.
Engineer.
Engineering.
Journal of the Royal United Service Institution.
Journal and Proceedings of the United Service Institution of New South Wales.
Le Moniteur de la Flotte.
Marine-Rundschau.
Militär Wochenblatt.
Minutes and Proceedings of the Institution of Civil Engineers.
Mittheilungen aus dem Gebiete des Seewesens.
Mémoires et Compte Rendu des Travaux de la Société des Ingenieurs Civils.
Norsk Tidsskrift for Sovaesen.
Proceedings of the Royal Artillery Institution.
Proceedings of the Institution of Mechanical Engineers.
Revista Maritima Brazileira.
Revista Tecnológico Industrial.
Revue du Cercle Militaire.
Revue Maritime et Coloniale.
Rivista di Artiglieria e Genio.
Rivista Marittima, Rome.
Steamship.
Teknisk Tidskrift.
Tidskrift i Sjöväsendet.
Transactions of the Canadian Institute.
Transactions of the Canadian Society of Civil Engineers.
Transactions of the Institution of Naval Architects.
Transactions of the North of England Institute of Mining and Mechanical Engineers.
Transactions of the North-East Coast Institution of Engineers and Shipbuilders.
United Service Gazette.
Le Yacht.

THE NAVAL WAR COLLEGE.

We have had occasion before to refer to the place in our naval system filled by the Naval War College. Probably no argument for its existence could be more convincing than the fact that the excellent works of Captain Mahan in the domain of strategy were there originated under the mainspring of duty, being delivered as a series of lectures to the College. As an afterthought, probably at the suggestion of some one who had a keen business instinct, they were delivered to the world, to appear, as they do, in the opinion of many of the great present leaders in thought, among the most wonderful literary productions of the 19th century. Such work is, of course, exceptional, but represents a standard which in future will be approached more or less nearly by those who will control the destinies of the College.

To show that there is no "lagging behind" in present contemplation, and at the suggestion of the President of the U. S. Naval Institute, we print the following circulars and order for the benefit of those members and subscribers who have not received them.

SPECIAL CIRCULAR } NAVY DEPARTMENT,
No. 20. } WASHINGTON, February 18, 1895.

1. The session of the Naval War College and Torpedo School for 1895 will commence on the first day of June next, and will terminate on the 15th day of October.

2. It is the intention of the Department to detail a class of about twenty-five officers (fifteen of and above the grade of lieutenant and ten below that grade) for attendance during the session. From this class it is proposed to select five officers to remain after the session to continue the general work through the winter and prepare for the next session. These five officers will be chosen for their aptitude in the work, and their attainments in International Law, Strategy, and Tactics.

3. The location of the principal problem of the session of 1895 will be the Cape Cod vicinity and a small section north of it. A beginning also will be made of a general strategic consideration of the Gulf of Mexico.

H. A. HERBERT, *Secretary.*

SPECIAL CIRCULAR } NAVY DEPARTMENT,
No. 22. } WASHINGTON, D. C., November 15, 1895.

The methods of work of the Naval War College as at present carried on having proved satisfactory, the Department directs that the following programme be carried out, in order that subjects shall be taken up in the order of their importance.

The study of the various portions of our coast, as examples of strategic and tactical conditions, will be continued by the permanent staff of the College. Reconnaissances will be undertaken when necessary, and such systematic exercises with launches, war games and problems as shall perfect a thorough preparation for the summer sessions.

During 1894 the session was devoted to—

1. From the Delaware to Cape Cod; and during 1895 to—
2. Cape Cod to the Penobscot.

Beginning the 1st of January, 1896, the programme will include in the order given—

UNDER COAST DEFENSE.

3. The Gulf of Mexico.
4. Delaware and Chesapeake Bays.
5. The lower lakes (Erie, Ontario, Champlain).
6. Puget Sound and Alaskan waters.
7. San Francisco to San Diego.
8. The coast from Cape Hatteras to Eastport, Maine, comprising the three sections already studied.

IN STRATEGY.

1. All strategic questions concerned in the above developments of our coast defense.
2. Special study of the strategy of the Gulf of Mexico and its vicinity.
3. Strategy of the Caribbean Sea.
4. The strategic features of the North Pacific and the Aleutian Islands.

IN NAVAL TACTICS.

1. The search for the most *desirable battle tactics.*
2. The best *formations* for the fleet for such *tactics.*
3. The *types of vessels* most suited for those formations.
4. *Tactical studies* of our coast and preparation for the naval defense of important localities.
5. The construction of *war charts* and the preparation of *defense plans.*

In the consideration of these subjects the methods now in use will be followed. These are, during the winter season, a study of naval and military history; the use of war games to assist in determining disputed questions in strategy and tactics, the frequent solution of strategic and tactical situations, and the exercising with steam launches.

During the summer sessions the officers in attendance will follow these lines and will in addition prepare solutions of special problems in the defense of our coast. There will also be a course of lectures bearing upon naval warfare and international law, by officers or civilians of special knowledge on these subjects.

The solutions of the problems in naval warfare studied at the Naval War College and the resulting confidential detailed plans when completed will be filed at the Navy Department.

H. A. HERBERT, *Secretary.*

SPECIAL ORDER } NAVY DEPARTMENT,
No. 40. } WASHINGTON, D. C., November 15, 1895.

1. The session of the Naval War College for 1896 will commence on the 1st day of June, and terminate on the 1st day of October.

2. It is the intention of the Department to detail twenty-five officers, twenty of and above the grade of lieutenant, and five below that grade, for attendance during the session.

3. From this class it is proposed to select five officers, upon the recommendation of the college, to continue the work of the college during the winter, and to prepare for the next year's session.

4. The officers detailed will therefore be selected when possible from those who have a year or more to serve on shore duty.

5. The location of the principal problem of the session of 1896 will be the Gulf of Mexico.

6. The construction of a war chart and defense plan of the Nantucket Sounds will be completed, and the general strategic consideration of Delaware and Chesapeake Bays will be begun.

H. A. HERBERT, *Secretary.*

OFFICERS OF THE INSTITUTE,

1896.

Elected at the regular annual meeting, held at Annapolis, Maryland, October 11, 1895.

President.

REAR-ADMIRAL S. B. LUCE, U. S. N.

Vice-President.

CAPTAIN PHILIP H. COOPER, U. S. N.

Secretary and Treasurer.

LIEUTENANT J. H. GLENNON, U. S. N.

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PROFESSOR N. M. TERRY, A. M., Ph. D.

LIEUTENANT J. H. GLENNON, U. S. N. (*ex-officio*).

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1897.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1897. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute: and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

J. H. GLENNON,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *Dec.* 31, 1895.

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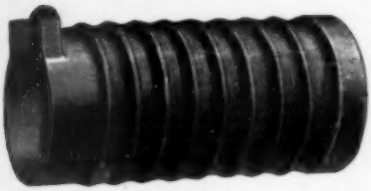

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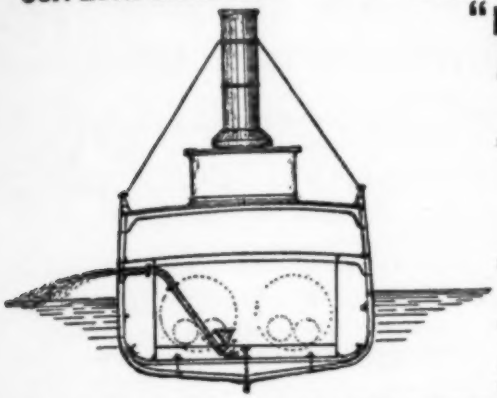

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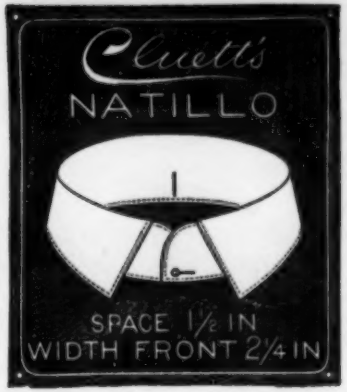

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PROCEEDINGS

OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XXI.

EDITED BY J. H. GLENNON.

PUBLISHED QUARTERLY BY THE INSTITUTE.

ANNAPOLIS, MD.

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NOTICE.

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It now enters upon its twenty-third year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII.

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

Sec. 5. Associate members shall be elected from officers of the Army, Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed by the Board of Control of use to the service will be published in the Proceedings.

Single copies of the Proceedings, $1.00. Back numbers and complete sets can be obtained by applying to the Secretary and Treasurer, Annapolis, Md.

Annual subscriptions for non-members, $3.50. Annual dues for members and associate members, $3.00. Life membership fee, $30.00.

All letters should be addressed to Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md., and all checks, drafts and money orders should be made payable to his order, without using the name of that officer.